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[SECOND SERIES.]

ART. XXXII.—*On the Fluctuations of the Water Level at Green Bay, Wisconsin;* by CHAS. WHITTLESEY, of Cleveland, Ohio.

THE town of Green Bay is situated at the mouth of the Fox (or Neenah) river. As far up the river as "Des Peres," or about five miles, the water is dead and deep enough for navigation by sail vessels. The first rapid is at Des Peres, the seat of the earliest French mission on the Fox river, taking its name from the Jesuit fathers, of whom relics yet remain. Here a dam and lock have been built as part of the improvement of the river.

Movements of the waters at the mouth and along the still water portion of the channel are so frequent and so marked as to attract the attention of travellers and residents from the days of the Jesuits to our own. The current is seen flowing rapidly up stream as far as the rapids almost every day, and sometimes more than once or twice. With the influx is a rise sometimes very small, at others reaching one and even *two* feet, as the following tables show.

Notwithstanding the curiosity excited by this series of movements, very few measurements have been made. The early numbers of this Journal contain, I believe, all the observations heretofore made, but I have not the advantage of referring to them. Those which I now present are by no means complete, but may be of some value in discussing the question of lunar influence.

In the month of August, 1858, at my request, D. UNDERWOOD, Esq., cheerfully consented to make hourly observations so far as it could be done consistently with his occupations. Mr. Underwood is the observer at Green Bay for the Smithsonian Institution at Washington: a capable and faithful person, having a strong inclination for all subjects connected with natural science.

The bay which has given its name to the town, is on an arm of Lake Michigan, about 120 miles in length, and its greatest width about 20 miles. It opens into the lake not so much by direct channels as by side ones among islands that lie across the mouth, which is about 25 miles in width. In general form it resembles the half-fledged wing of a bird attached to its body by its side and at the largest end. The general direction of its axis or middle line is northeast by north, making an acute angle with the coast line of Lake Michigan. A narrow peninsula coming to a point at the "Port-des-Morts," lies between the bay and the lake, rising from 100 to 200 feet above the water level. The western shore of the bay is low and swampy; winds that blow across the bay from the northwest, therefore, act more powerfully on its waters, locally considered, than those from the opposite quarter over the bluffs of the eastern shore. At Green Bay and Fort Howard the shore lines approach to a point.

From Mr. Underwood's register I have to a considerable extent condensed the readings so as to express them in substance, in the form of curves. At the broken or dotted portions the observations are wanting. We assumed an arbitrary line or plane of reference intended to be above the floods of the year 1858, and called this *zero*.

Constructing a water-gauge, marked to half inches, it was nailed to a pile at the south side of the dock of Day & Brothers, its zero corresponding with the assumed line, the figures reading downwards. The readings were made hourly during the day, but were necessarily deficient for most of the nights.

By means of the tables and of the diagram [see Plate] the written portion of this article is very much abridged.

Two columns at the left show the time of high water, and approximately the hour of the moon's southing on the same day. The period which should elapse between the meridian passage and high water is subject to so many collateral influences that it is not determined without long continued observations. But for the same place it must be nearly constant, and a tide arising from that cause would therefore occur with regularity. The space occupied by the corresponding strength and direction of the winds, as observed locally, exhibits only their prevailing or general condition.

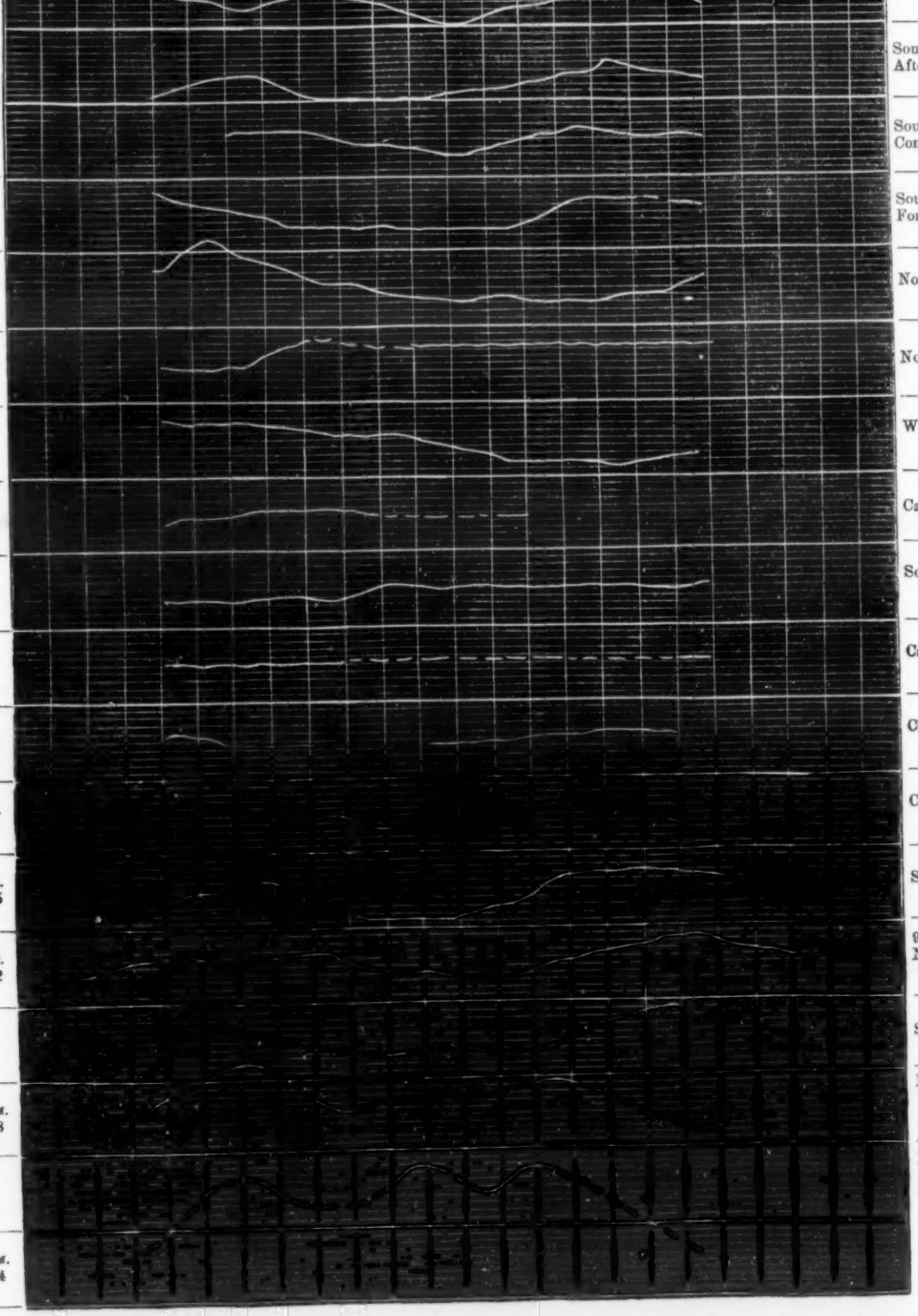
On the 22d of September only four hours passed without observations, but most of the days began at 5 A. M. and closed at 7 P. M.

WATER LEVELS, GREEN BAY, WISCONSIN.—*Curves of fluctuation deduced from the Observations of* D. UNDERWOOD, Esq.

VOL. XXVII.] *Zero*, the line above each date counting downwards—*Scale* 20 inches to half an inch. [Art. XXXII, p. 306.

DATE, 1858.	HOUR, A. M.	M.	HOUR, P. M.	GENERAL DIRECTION AND FORCE OF WINDS AND REMARKS.
Hour of flood.	Moon south.	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	
July 1st. 10½ A. M.	h. m. 3 50 A. M.			July 1st, wind S. E. to calm. Conjunction, July 10th.
" 2d & 3d 12 midnight.	4 52 A. M.			July 2d, in the morning, S. 2; midnight, 2d and 3d, N. 4; water 16½ inches, A, and at Des Peres 20½ inches; furious northerly gale.
Aug. 18. 8. P. M.	7 43 P. M.			Aug. 18, N. W. 1 to 3. Conjunction, Aug. 8th.
" 19th. 6½ A. M.	8 34 P. M.			Afternoon, S. W. 1 to 3. Forenoon, light S. W.
" 20th. 6 A. M.	9 25 P. M.			Forenoon, light S. W. Afternoon, N. 1 to 3.
" 21st. 9 P. M.	10 14 P. M.			Forenoon, S. W. to W., 0 to 2. Afternoon, N. W. 2.
" 22d. 7 A. M.	11 1 P. M.			East 0 to 2.
" 23d. 7 A. M.	11 46 P. M.			West 1; clear. Ther. 5 A. M. 46° F.
" 24th. 6 A. M.				Forenoon, S. W. 1 to 0. Afternoon, N. 1; Ther. 48°.
" 25th. 8 A. M.	0 30 A. M.			South 1; cloudy.
" 26th. 6 A. M.	1 12 A. M.			Calm to S. 1; cloudy.
" 27th. 8 A. M.	1 57 A. M.			North 2 to 3; rain; Ther. 58°.
" 28th. 5 P. M.	A. M. 2 42			North 2; cloudy.
Sept. 1st 8 A. M.	A. M. 6 20			South 0 to 2; clear; Ther. 64°.
" 2d. 6. P. M.	A. M. 7 23			South 1 to 3; cloudy; Ther. 64°.
" 3d. 9 A. M.	A. M. 8 26			South 2 to 4; cloudy.
" 4th. 5 P. M.	A. M. 9 26			Southwest 1 to 2; A. M., cloudy. Afternoon, clear.

" 4th. 5 P. M.	A. M. 9 26	Southwest 1 to 2; A. M., cloudy. Afternoon, clear.
" 6th. 4 P. M.	A. M. 11 14	South 0 to 2; calm and cloudy. Conjunction, September 7th.
" 7th. 5 P. M.	P. M. 12 2	South 2 to 3 till 6 P. M., then N. 1. Forenoon clear; Afternoon cloudy.
" 8th. 6 A. M.	P. M. 12 48	North 0 to 2; cloudy.
" 9th. 8 A. M. to 7 P. M.	P. M. 1 33	Northeast 1 to 2; cloudy.
" 10th. 5 A. M.	P. M. 2 19	West 1 to 3; cloudy.
" 12th. 8 A. M.	P. M. 3 54	Calm; Ther. 30°.
" 13th 11 A. M. to 7 P. M.	P. M. 4 42	South 0 to 1; Ther. 40°
" 14th. 12 M.	P. M. 5 35	Calm.
" 15th. 5 A. M.	P. M. 6 26	Calm.
" 16th. 5 A. M.	P. M. 7 17	Calm.
" 20th. 5 P. M.	P. M. 10 25	Southwest, 1 to 3; clear.
" 22d. 7 P. M.	P. M. 11 52	9 A. M. to 4 P. M., clear; Ther. 48°. North, 1; after 4 P. M. calm and cloudy.
" 23d. 7 P. M.		Southwest, 1; cloudy.
" 24th 3 A. M.	A. M. 0 38	Northeast gale at half past 12 A. M. to 3 A. M.; N. E. 4½—7 A. M.; 4—7 P. M. calm.
		Northeast gale Oct. 31 P. M. to afternoon of Nov. 2d. Conjunction, Nov. 5th.
Nov. 2d. 2 P. M.	A. M. 9 24	At Oconto River the water fell 12 inches with the wind still northeast.



NOTE.—Thermometer read at 5 A. M.—Lowest water of the season, Oct. 16, 2 P. M., being 24½ inches, B, wind S. 3.—Highest, Nov. 2d, 2 P. M., 15 inches, A, wind N. E., a gale.—Difference 39½ inches.—April 17, 1848, 23 inches, A.

The position of Green Bay is more favorable for detecting a lunar tide, if it exists, than a point on the shore of the lake. In inland seas of much greater size, such as the Baltic and the Mediterranean, which connect directly with the ocean, only a small tide is observed. I am not aware that it has been noticed in the Caspian and the Black Seas. On the open sea the rise and fall is slight, ranging from two to three feet only.

The great vertical range of tides in our harbors on the coast arises from the configuration of the shore and the form of the ocean bed. The sweli is augmented of necessity as it is driven into bays and inlets with converging shores and shallow water. At the mouth of the Bay of Fundy the tidal wave has thus been raised to 10 and 12 feet, and running into the bay it attains a height of 30 and 40 and at spring tides of 60 feet. The contour of Green Bay is much the same. A swell of two inches at the Port des Morts when carried on and compressed between the converging shores should produce a rise of six or eight inches.

It has been long known that on the western lakes there is a land and water breeze occurring daily, as happens on the coast of the ocean. Its regularity may be disturbed by storms, but without these a breeze begins gently to draw off shore between seven and eight in the evening, sufficient to take vessels out of harbor. About ten in the morning following, the reverse is witnessed. In the cold months, a sluggish, but damp and chilly, current of air moves from the water towards the land. It is productive of congestion of the skin, oppresses the lungs, produces torpor in the animal system, and increases the flow of blood to the head. The evening breeze has the opposite effect. Without assuming, in the present state of the observations, that the moon produces no perceptible effect on the waters of the lakes, I offer some deductions that I think follow from the register of Mr. Underwood, showing a direct connection between the winds and the rise and fall at Green Bay.

This effect is complicated but may be philosophically explained. A land breeze commencing at the Port-des-Morts, would in due time press the waters into the bay, more or less according to its duration and force. A water or off-land breeze would depress the water, but owing to the form of the bay and the coast the effect should be less in amount. These breezes are regular.

The winds and gales that occupy the whole surface of the lake, are irregular in their occurrence. They overcome in many cases the minor currents that flow and reflow across the shore line otherwise daily, to and from the land. These limited currents arise from the unequal heat of the day and of the night. Suppose a powerful norther is raging on the lake, driving the navigator towards its southerly extremity, where the chances of

shipwreck are at least equal to those in favor of his escape. The gale carries the water along with it, and at Chicago and Michigan City there is a rise in the surface of three to four feet. At the Beaver Islands and at the Port-des-Morts there is a corresponding depression. The waters of Green Bay must therefore tend to flow out. But the same wind operating within the basin of the bay, resists the flow of water to the north, and diminishes the result that would otherwise follow, depressing the surface at the town of Green Bay. A gale from the east and northeast acts in *favor* of a rise, both directly and indirectly. Its tendency is to force more water into the bay and to retain what is already there. Accordingly we should anticipate very high water under the influence of prolonged northeasterly winds. But even here as I witnessed at the Oconto River, November 2d and 3d, 1858, a reflux may occur while the wind holds in the same quarter. On the 2d at noon the water was at its greatest known height. At noon on the 3d it had fallen 12 inches although the same gale continued.

Gales from the south and southwest should produce hydrographical effects the reverse of those from the north, and have the same double action. If they continue long, the water in the lake is raised at its northerly end, and tends to flow into the bay, raising its surface. Within the area of the bay, however, the tendency is to drive water out of it, and to depress the surface at the mouth of the Fox River. Here is again the question of the resultant of opposing forces.

The diagram and its attendant columns show a direct connection between the northeast winds and the extreme floods of the season. The 2d of July, the 20th, 21st and 27th of August, the 8th, 9th and 24th of September, and the 2d and 3d of November are cases of this sort.

But to present this part of the subject more fully I insert a table of the extremes of both the ebb and the flood during 29 days which have the fullest record. [See table, next page.]

From this table it appears that in all cases where the force of the wind during the day reached 2 and over, there was a *difference of level* of eight inches or more, with the exception of Sept. 1st, when it was only 6½ inches. The wind that day was southerly. There is one case (Sept. 9th) of a range of 8 inches where the force of the wind (northeast) was only 1. In another case (Sept. 25th), where the record of the previous day was not taken, there was a fluctuation of 10½ inches without any wind observable at the town of Green Bay. Observations on the coast are necessary to elucidate such cases. On the 25th also there was a range of 9 inches under similar circumstances.

By the registers, there were 17 days in which the flood occurred *twice*, having two maxima, and 15 days with but one.

High water occurred in the forenoon 18 times and in the afternoon the same number. Low water took place in the forenoon 9 times and in the afternoon 12. With the wind northerly, of an east and west line, high water occurred 12, and with it southerly 5 times. There was a flood in calm weather 10 times, and an ebb 8 times.

Extremes of fluctuation for August and September, 1858.

	HIGH WATER.		WIND.		LOW WATER.		WIND.		Daily range.
	Hour.	Below zero.	Direction.	Force.	Hour.	Below zero.	Direction.	Force	
Aug. 19.	6 A. M.	3 inches.	Calm.	0	2 P. M.	12 inch.	S.W.	2	9 inch.
" 20.	6 A. M.	3¼ "	"	0	5 "	16½ "	N.	2	13 "
" 21.	9 P. M.	4½ "	W. by N.	1	12 M.	13¾ "	W.	2	9¼ "
" 22.	6 A. M.	0½ "	N.	1	2 P. M.	12 "	N.	1	11½ "
" 23.	6 "	4 "	W.	1	12 M.	14½ "	W.	1	10½ "
" 24.	6 "	9 "	Calm.	0	1 P. M.	15½ "	N.	1	6½ "
" 25.	7 "	8 "	S.	1	2 "	13 "	S.	1	5 "
" 26.	6 "	7 "	Calm.	0	3 & 5 P. M.	13 "	S.	1	6 "
" 27.	6 & 9 A. M.	1 "	N.	3	2 & 3 "	11½ "	N.	3	10½ "
" 28.	5 P. M.	1 "	N.	2	11 & 12 P. M.	9 "	N.	2	8 "
Sept. 1.	7 & 9 A. M.	8 "	S.	1	5 A. M. & 2 P. M.	11 "	S.	1	3 "
" 2.	6 P. M.	5 "	S.	2	4 P. M.	16 "	S.	3	11 "
" 3.	9 A. M.	11 "	S.	2	1 "	20½ "	S.	3	9½ "
" 4.	5 P. M.	9½ "	S.W.	1	9 & 10 A. M.	20 "	S.W.	2	10½ "
" 6.	4 "	7½ "	S.	2	1 P. M.	14 "	S.	2	6½ " *
" 7.	5 "	5 "	N.	1	12 to 2 P. M.	14 "	N.	3	9 "
" 8.	6 A. M.	3, A	N.	2	4 P. M.	13 "	Calm	0	16 "
" 9.	8 A. M. to 7 P. M.	5, B	N.E.	1	5 A. M.	13 "	N.E.	1	8 "
" 10.	5 & 6 A. M.	5 "	W.	1	4 & 5 P. M.	17 "	W.	2	12 "
" 13.	11 A. M. & 7 P. M.	9 "	S.	1	5, 6 & 7 A. M.	13 "	Calm	0	4 "
" 14.	12 M.	8 "	Calm.	0	5 to 9 A. M.	10 "	"	0	2 "
" 15.	5 A. M.	8 "	"	0	12 M.	11½ "	"	0	3½ "
" 16.	5 "	7½ "	"	0	11 A. M. to 1 P. M.	13 "	"	0	6½ "
" 20.	6 P. M.	6 "	S.W.	2	10 A. M. to 12 M.	18 "	S.W.	3	12 "
" 22.	7 "	3 "	Calm.	0	2 A. M.	13½ "	Calm	0	10½ "
" 23.	7 "	2 "	"	0	2 P. M.	14 "	N.	1	12 "
" 24.	3 A. M.	4½ A	N.E.	4	7 "	15 "	Calm	0	19½ " †
" 25.	8 "	3 B	Calm.	0	6 A. M.	12 "	"	0	9 "
Nov. 2.	2 P. M.	15 A	N.E.	Gale.	‡				

Abstract of the number of times high and low water occurred under the influence of different winds.

	North.	N.W.	West.	S.W.	South.	East.	N.E.	S.E.
High water, - -	6 times	0	2	2	5	0	10	0
Low water, - -	7 "	0	3	3	6	0	8	0

* High at 7 and 8 A.M. and 5 P.M. ‡ At 7 A.M., 12 A, at 12 M. 14 inches, A.
† Gale from N.E. began at midnight, 23d and 24th.

From the 1st to the 16th of September inclusive, the moon's southing occurred within the hours of the readings for high and low water. Of these days, on the 1st and 3d the flood arrived within *two* hours after the passage of the moon. On the 2d, 4th, 6th and 7th from 5 to 11 hours afterwards. On the 8th, 9th, 10th, 12th, 13th, 14th, 15th and 16th from 5½ to 11½ hours before southing, but on the 9th and 13th there were two maxima 3 to 5½ hours after. From the 12th to the 15th inclusive, four days, the weather was continually calm at the place of observation. The variation of level during those days was small, the mean being *four* inches, the least 2, and the greatest 5½ in. This was the most favorable opportunity for the appearance of a lunar tide. The period of conjunction passed on the 7th, and consequently the calm weather all came within the first quarter. Neither on those days or during the most quiet periods embraced in Mr. Underwood's register, do I discover evidences of a flux and reflux that I can connect with the moon's motions.

Perhaps more perfect and prolonged observations might disclose such evidence. No station can be found better calculated to test the question fairly, provided simultaneous observations are made at the mouth of the bay. It is to be hoped the attention which the officers of the United States Topographical Corps are now giving to the subject of lake fluctuations will lead to such observations.*

Art. XXXIII.—*On Parthenogenesis*,† by E. Regel.

Thousands of accurately observed cases bear evidence that an embryo can be developed in a seed only under the influence of fecundation. A few naturalists did, indeed, up to the beginning of the present century, deny the necessity of fecundation, but these were solitary voices (Schelver and Henschel‡). The theory of fecundation, the practical proof of it (the production of hybrids), was assumed to be a settled fact, and up to our own time underwent a continually fuller development.

A few voices were here and there raised, not against the theory of fecundation generally, but for the proposition that in certain plants a true embryo might be formed without fecundation, where this was hindered; in other words, it was assumed that, "*Normally, the embryo is developed in a seed only under the influ-*

* See an Appendix to this paper in the miscellanies beyond.

† Botanische Zeitung, Oct. 8, 1858. Translated by Arthur Henfrey, F.R.S., &c. Cited from the Ann. and Mag. of Nat. Hist. xiv, 100.

‡ Henschel, von der Sexualität der Pflanzen, nebst einem historischen Anhange von Dr. F. J. Schelver. Breslau.

ence of fecundation. But if the fecundation is prevented, in certain cases an embryo may be nevertheless developed." Strictly speaking, therefore, it was assumed in this statement that the male sexual organs of plants were wholly superfluous structures.

But this assertion was made always in reference only to particular plants, and indeed to the same with which Spallanzani had experimented in the year 1786, namely hemp and spinach.* How inexact Spallanzani's observations must have been, appears from the fact that he obtained ripe seeds even from basil from which he had removed the anthers, also from watermelons, &c.

On these latter and similar plants, on which it is easy to operate, there exist a number of direct experiments to show that the prevention of fecundation hinders the production of seeds capable of germination; these and similar observations have been repeated subsequently by persons who were wholly destitute of the knowledge requisite for an exact experiment. On the other hand, Bernhardi, an otherwise very exact observer, repeated Spallanzani's experiments on hemp,† and obtained exactly similar results.

This question then sank to rest again; Bernhardi's observations were explained by assuming inaccurate observation, or the formation of a bud in the seed.

In 1841, J. Smith‡ made known his observations on the production of seed by *Cælebogyne ilicifolia*, which was stated to perfect all its seed without any fecundation. At the same period Lecoq asserted the occurrence of parthenogenesis in a host of plants. From his superficial observations he drew the conclusion that all annual plants with separate sexes could form perfect seeds without fecundation. By such a wise contrivance, nature prevented the dying-out of such plants.

Cælebogyne is still in very few hands in flowering condition. So far as we know, it has not been observed, from the period of flowering to the ripening of the fruit, by any German botanist. Observations on the so-called unfecundated seeds, such as were made by Radlkofer, Klotzsch, and A. Braun, can have but a conditional importance. That all has not been seen that may be seen, in this plant, is evident from the fact that while Klotzsch demonstrated, from the formation of the seed of this plant, that it contained not an embryo at all, but a bud, Radlkofer and A. Braun are of the opposite opinion. The latter, however, made a most important observation, still unexplained by him, namely, that he found a pollen-grain with a pollen-tube on the stigma of *Cælebogyne*.

* Spallanzani, Expériences pour servir à l'Histoire de la Génération des Animaux et des Plantes. Geneva, 1785.

† Otto und Dietrich, Allg. Gartenzeitung, 1839, pp. 327, 329.

‡ Trans. Linnæan Society of London, 1841, p. 509.

In leaving *Cœlebogyne* to one side, since those only are competent to speak of it who have had an opportunity to observe it, it may be noticed that this plant has been the cause of the resuscitation of the question as to the possibility of parthenogenesis in the vegetable kingdom, and this the more that a similar phenomenon in the animal kingdom was simultaneously asserted by von Siebold. Naudin and Decaisne in particular took up again the earlier experiments on *Spinacia* and *Cannabis*, adding to them a number of other plants. The result of their experiments was, that female plants of *Spinacia*, *Cannabis*, *Mercurialis annua*, and *Bryonia dioica* bore perfectly ripe seeds when they had been sufficiently guarded against the accidental influence of the pollen of male flowers. According to M. Naudin's report, neither he nor M. Decaisne could discover male flowers among the female flowers, which were borne in great numbers. On the other hand, *Ricinus communis* and *Ecbalium Elaterium* bore no seed when all the male flowers were removed before they opened.

Naudin concluded from his observations "*that only diœcious plants are capable of perfecting seeds without fecundation, while monœcious plants perfect their seed only under the influence of fecundation.*"

Radlkofer, from the cases made known by Naudin and Smith, deduced the further law, "*that ovaries which perfect their embryos without fecundation retain their stigmas much longer in a fertilizable condition than is the case when the embryo originates in consequence of regular fecundation.*"

As usual, the majority of naturalists have accepted these statements, promulgated as certain facts. The very circumstance that, in the supposed discovery, all those laws which we have invariably recognized in reference to the origin of embryos are opposed face to face—the attraction of the wonderful, which in these days possesses a powerful charm,—has brought many over to the party who believe in a parthenogenesis.

The author of this notice has expressed, in the last year or two ('Bonplandia,' 'Gartenflora'), his modest doubt as to the accuracy of the experiments of Naudin and Decaisne, which served as the basis of an hypothesis of so great weight.

An objection arose in the outset, from the fact that the result was obtained only in small-flowering plants which developed a mass of flowers in every leaf-axil, while large-flowering plants, like *Ricinus* and *Ecbalium*, bore no seed when fecundation was prevented. Still more striking was it, that, of plants known to be polygamous, only female plants were mentioned, and an assurance was given that no male flowers were observed upon them.

I have in the present summer repeated the experiments made by Decaisne and Naudin. Although they are not yet quite concluded, they have afforded me proof that Decaisne and Naudin

have observed but superficially, and that neither *Spinacia* nor *Mercurialis* are to be included among plants which can furnish proof of parthenogenesis.*

Plants of *Spinacia*, *Mercurialis annua*, and *Cannabis* were planted singly in pots; and the male plants were removed as they appeared, before the dehiscence of the earliest anthers. The female plants were kept in a place where no pollen from similar plants could have access to them. As soon as the first flowers were perfectly developed, they were cut away so as to leave only a few axillary inflorescences which could be easily examined. All newly-produced lateral branches, which were abundantly developed, were carefully removed, and the inflorescences of the plants experimented on observed daily with a lens. These observations refer, up to this period, only to *Mercurialis* and *Spinacia*, as *Cannabis* has not yet unfolded any flowers.

Mercurialis.—One of the female plants was placed in a different locality, where it grew freely without being cut. This plant has now set abundance of fruit, which will doubtless bear perfect seeds with embryos. But on examination it was found that solitary perfectly developed male flowers were produced in the axillary tufts of flowers, as can be testified by MM. Körnicke, Rach, and Maximowicz, to whom I showed them. How this escaped the observation of MM. Naudin and Decaisne, is beyond my comprehension.

Two plants of *Mercurialis* were cut in and observed in the above described manner. Each of the few tufts of blossom produced a great number of female flowers. Here, again, solitary male flowers continually made their appearance, so that I have already removed more than twenty of them from each of the experimental plants. Even with the most careful observation, an absolutely conclusive result could scarcely be obtained with this plant; for the male flowers are only detected after they have opened, and therefore may have scattered pollen. I used my utmost endeavors to suppress the male flowers at the right time; and in fact hitherto neither of the experimental plants have set fruit, all the earliest developed female flowers having withered up. But if these plants should still set fruit, this must be attributed to pollen received from some of the male flowers.

Spinacia.—Difficult as it is in *Mercurialis* to neutralize the influence of pollen from adventitiously developed male flowers, it is still more difficult with *Spinacia*. All the experimental plants were cut in. I observed at first, in the axillary tufts of female flowers, solitary normally developed anthers, which projected over the female flowers. I removed them, and placed the plants

* I have not yet full observations upon *Cannabis*; but this will doubtless furnish similar results.

on which I had noticed them in a different locality. All my experimental plants appeared inclined to set seeds. I therefore placed all except one, on which the first flowers were beginning to unfold, in another situation, and continued the examination of this plant with redoubled attention, allowing in all only ten axillary tufts of blossom to come to perfection. All newly-produced lateral branches were necessarily broken off, as these at once developed new blossoms. First of all, I observed on this plant two stamens with anthers containing abundance of pollen. Placed under the microscope, this exactly resembled normal pollen. These stamens, however, did not arise (as I observed in *Chamærops* last year) from female flowers; but among the female flowers were scattered solitary stunted male flowers, which brought only one stamen, seldom more, to perfection. This fixed my attention. With the help of the lens, I soon saw, in the tufts of female flowers, isolated gland-like bodies, which I had taken at first for misshapen bracts. When I had dissected them out, I found that they were *sessile anthers*, developed in scattered abortive male flowers. These contained perfect pollen, as the above-mentioned gentlemen as well as myself can testify. These anthers are seldom perfectly seen, but are almost always partly covered up by the involucral scales of the flowers in which they arise, so that they may be easily overlooked or be taken for transformed bracts. In the isolated male flowers I usually found one sessile perfect anther, with several abortive; more rarely several perfectly developed anthers filled with pollen (all, however, sessile) exist in one flower. From one single axillary inflorescence I dissected out ten such male flowers with sessile perfect anthers. But as this had to be done on living plants under a lens, it could seldom be effected without injuring the anthers, by which pollen was always scattered. In such cases, I indeed removed the immediately adjacent female flowers; and the withering away of the earliest female blossoms was the result. At present, however, several appear to be swelling into fruit.

The very abundant development of axillary flowers here is of course a result of the cutting back of the plant and the removal of the lateral shoots which continually break out afresh from the axils, since the formative energy is wholly diverted to the development of flower-buds. A large proportion of the experimental plants did not bear this injury, and soon died away.

Whether the experimental plants of *Spinacia* and *Mercurialis* perfect seeds capable of germination, or not, these experiments have already fully convinced me that these two genera only develop perfect seeds under the influence of the pollen of adventitious male flowers, and that the only possibility of preventing fecundation is by daily repeated observation of every single

flower that unfolds, limitation of the growth of the plant to a few tufts of inflorescence, and rightly-timed removal of each male flower which makes its appearance. An observer who merely looks over a number of female plants with thousands of little flowers, cannot possibly obtain any result of the slightest scientific value. Surveying therefore the conclusions drawn from these experiments, it becomes evident that they have no authority.

That *Ricinus* and *Ecbalium* perfected no seed, evidently arises from the fact that in these plants the male flowers may be easily enough detected in time and removed, which can scarcely be accomplished with certainty in *Mercurialis* and *Spinacia*, since, from the small size and close packing of the flowers, these can only be detected when too late, even if these flowers are not altogether overlooked. There is no ground for making a distinction between monœcious and dicœcious plants in this respect.

The same is the case with the stigmas. All the flowers of my experimental plants that were really protected from fecundation soon withered, stigma included. When, on the other hand, fruit was formed in consequence of fecundation, the stigmas persisted a long time, which is by no means wonderful, considering the fleshy nature of the stigmas of these plants.

As soon as *Cannabis* flowers, this plant shall also be subjected to careful examination. I may be permitted to notice beforehand, that the results of previous observations on *Cannabis* have been very varied. Some obtained no seeds on separate female plants (Linnæus obtained this result); others obtained abundance of seed. It seems to be indicated by this, that in *Cannabis* there occur individuals bearing only female flowers, and others which may resemble those of *Spinacia* or *Mercurialis*.

We possess plants of *Cœlebogyne;* but, unfortunately, none of them have yet flowered. Yet I am convinced that in this plant careful observation will clear up the matter. I may refer to the peculiar glands which surround the female flowers, with which solitary imperfect anthers might be easily confounded.*

Parthenogenesis certainly does not occur in plants with evident sexual organs.

Petersburg, Aug. 13, 1858.

* The author does not appear to be aware that the characters of the male flowers of *Cœlebogyne* are well known. M. Baillon has proposed the same unsatisfactory explanation of this case.—A. H.

ART. XXXIV.—*Terrestrial Climate as influenced by the Distribution of Land and Water at different geological epochs;* by HENRY HENNESSY, F.R.S., M.R.I.A., Professor of Natural Philosophy in the Catholic University of Ireland.*

EVERY point on the earth's surface is continually gaining and losing heat, and its actual temperature at any given moment depends on the difference between its gains and its losses. If the outer coating of the earth were exclusively composed of solid materials, terrestrial climate would depend principally on the heat gained from sunshine and the heat radiated into space. But as the earth is completely enveloped by an atmosphere, and partly surrounded by a liquid, its thermal conditions must be greatly influenced by the physical properties of these fluid coverings. While the heating or cooling of a solid follows the clearly defined and comparative well understood laws of conduction and radiation, the heating or cooling of gases and liquids is further greatly modified by the mobility of their particles. The changes of state which frequently take place in fluids, whether by evaporation or condensation, freezing or liquefaction, introduce agencies which still further complicate the study of their thermal relations.

When we study the thermal conditions of a liquid distributed over the terrestrial spheroid, it becomes manifest, that these conditions are influenced by the area, configuration, and physical structure of such portions of the solid earth as rise above the ocean and come in contact with the atmosphere, so as to constitute the surface of the dry land. Upon this matter I propose to develop certain views which are closely connected with those I have already published relative to the distribution of heat over such solid surfaces.†

2. When a surface, covered with ordinary soil, receives the rays of the sun, the heat thus acquired passes downwards, but on arriving at a very small depth its intensity rapidly diminishes. The solar heat which is thus received by the ground may, therefore, be considered as confined almost entirely to a thin superficial stratum. The air in contact with the soil becomes heated, expands, and tends to ascend: a circulation thus follows between the upper and lower strata of the atmosphere situated above the heated ground. During the night a different process takes place; for then the radiation of the soil causes its temperature

* Cited from the Alantis, for January, 1859.

† On the Distribution of Heat over Islands, etc., Atlantis, No. ii, p. 396. See also the Note on the Laws that Regulate the Distribution of Isothermal Lines, No. iii, p. 201.

to fall below that of the superincumbent air; the coldest stratum of the lower portions of the atmosphere being in contact with the ground, the equilibrium of those above is not so much disturbed. Yet, even in this case, causes exist which tend to produce a series of actions and reactions between the upper and lower strata of air, by which a process of convection will be ultimately developed. These actions will be rendered especially remarkable if the soil is not bare, but covered with vegetation in the manner of the greater part of the dry land. This question has been fully treated by Melloni,* in his memoir on the nocturnal cooling of bodies. His general proposition, that "a body exposed during the night to the influence of a sky of equal clearness and calmness, is always cooled to the same extent, whatever may be the temperature of the air," is fruitful in important results. Thus is explained the great differences between the temperature of the day and night on land in the torrid zone. The intense cold observed during the night by Denham in traversing the great Desert of Sahara, the process of artificial freezing at Bengal, and the rain-like dews observed by Humboldt in the forests of South America, are all necessary consequences of the energy of the actions and reactions by which the outer coating of the earth loses the warmth it has acquired from sunshine during the day. Conversely, the almost constant temperature of the sea in tropical regions, by day and night, and the nearly total absence of dew on the rigging of vessels far removed from the land, clearly show the peculiar retentiveness of heat possessed by the water, and that, unlike the land, it does not readily part with whatever warmth it may have acquired from sunshine during the day. The cold southerly breezes sometimes observed in Egypt† during the winter months, when the air has passed over immense surfaces of sandy desert, present a striking contrast to the southwesterly winds which at the same season traverse the ocean and visit our shores. It appears, from a communication in the *Times* newspaper, dated Melbourne, November 15, 1858, that in South Australia, the coldest winds during the winter months, are those blowing from the northerly and tropical regions, while the warmest are those blowing from the pole. The former pass over extensive surfaces of heat-radiating, and therefore heat-losing land, while the latter traverse the heat-retaining ocean. In the summer (at least by day) the opposite phenomena are observed, of warm winds from the north and cold from the south. Combined observations on the wind, and on temperature, by day and night, would further elucidate a problem which, in the words of the writer, "cannot be solved

* Taylor's Scientific Memoirs, vol. v, pp. 453 and 530; and Annales de Chimie et de Physique, for February and April, 1848.

† Kaemtz Metéorologie, French edit., p. 45.

without greatly adding to the stock of our knowledge." While the feeble conducting power of the solid portion of the earth's coating, allows but a small portion of the sun's heat to pass beneath the surface, so that whatever warmth is thus received on that surface during the day is readily radiated into space during the night, a liquid mass, similarly exposed to sunshine and subsequent nocturnal radiation, possesses peculiar properties which greatly influence the differences between its thermal losses and gains. The most important of these properties are, (1) the great capacity of water for heat, by which it gradually accumulates and slowly parts with whatever warmth it has received; and (2) the intermobility of its particles, by which exchanges of temperature in different parts of the liquid mass are essentially promoted.

Let us consider the effect of the sun's rays on a globe covered with water, and we shall soon perceive that a more energetic process than that of conduction accompanies the exchanges of temperature between the different portions of the fluid. The water which receives the vertical rays of the sun will be more heated than the waters which receive its rays at more oblique inclinations. Not only the amount of warmth received over a given area, but also the depth to which the rays of heat penetrate below the surface, depends upon the angles made by these rays with the vertical. Inequalities of surface temperature, depending on the latitude, the hour angle, and the sun's longitude, should thus result. The more heated waters would expand, and tend to spread over the cooler waters in other regions. Currents should arise from the mutual actions and reactions of the unequally heated portions of the fluid. The colder currents would usually tend to flow beneath the warmer, unless at temperatures approaching that of the maximum density of water, and thus a process of circulation would be established by which the temperature acquired by the superficial strata of the water should be ultimately propagated to a certain depth below the surface. Evaporation would also take place, and by the condensation of vapor a certain portion of the heat received by the water would be imparted, in the formation of clouds, to the superincumbent atmosphere.

If, as in the existing oceans, this water be salt, the inequalities of temperature producing inequalities of evaporation, will also produce diversities in the density of the water in different regions, and thus additional energy will be imparted to the process of circulation. The salter and heavier surface water will tend to sink into the colder liquid which lies beneath, and which shall naturally tend to take its place, by ascending upwards. The process of evaporation would cool the surface of the water; but, unlike that of radiation, it is not altogether a losing process

as far as the entire surface of the earth is considered; for it is sooner or later followed by condensation, whereby the greater part of the absorbed heat is again returned. When a piece of land or water parts with its heat by radiation into space, that warmth can never be restored to any part of the earth's surface; but whatever heat the water loses by evaporation, becomes latent in the vapor so produced, and is ultimately transferred by condensation to some other part of the globe; and hence evaporation does not constitute an agent in causing a diminution of general terrestrial temperature. Let us now suppose a sheet of water at the equator nearly surrounded by fixed boundaries, so as to form a species of immense lagoon. Its temperature, from the causes here referred to, will rapidly augment. The heat which it has acquired during the day shall have penetrated so deeply as to be incapable of being radiated backwards into space during the night, with the same facility as on the surface of a sandy plain or from the summits of a mass of vegetation. Its temperature should thus continue to accumulate up to a certain limit imposed by the conditions of evaporation, and it might ultimately attain a mean temperature superior to any which is now met at the surface of intertropical seas.

3. These views are strikingly illustrated by the phenomena accompanying the origin of the Gulf Stream. The mass of water which rushes into the Gulf of Mexico, along the southern shores of the Carribbean Sea, has already acquired a certain elevated temperature from the action of sunshine in the southern torrid zone in its passage from Cape St. Roque. In moving around the Caribbean Sea and the Mexican Gulf, these waters still continue under the influence of a tropical sun, and are constantly increasing in temperature. The islands and coasts which they happen to bathe, have no part in directly promoting this augmentation. On looking over the isothermal chart of the Caribbean Sea and Gulf of Mexico, prepared by Mr. Charles Deville,* it becomes manifest that in general the temperature decreases in going towards the land. In some places the mean annual temperature of the water close to the land is 24°·5 Centigrade; further out at sea it is 25°, and still further from the land it is 25°·5. In other places it gradually augments from 26°, in going from the land, up to 27°·4.† These results are unconnected with the influence of latitude, and they are still less explicable by the influence of centrifugal force, in driving the cooler and heavier waters towards the edges of the great current, in its semi-rotatory movement around the gulf. For in this case the law of decrease of temperature in going from the

* Annuaire de la Société Météorologique de la France, tom i, p. 160.

† Reduced to degrees of Fahrenheit's scale, these numbers, arranged in the same order as in the text, are 76°·1, 77°·0, 77°·9, 78°·8, 81°·3.

land, should not hold on approaching the coasts of large islands situated towards the centre of the moving mass of waters. But, in such instances, it is also manifested; for on the north and south coasts of the Island of Cuba we find the isothermal lines of 26°·2 and 26°·5, while the isothermals of 26°·7 and 26°·8 are situated outside them respectively.* In Mr. Deville's chart these are closed isothermals, similar to those which I have indicated on the surface of the British Islands; but as the lowest isothermals in my map are the most remote from the sea, those in his chart which exhibit the highest temperature are farthest from the land. It is thus apparent that the intertropical sea may become a storehouse of heat, by retaining much of what it receives from the sun, which, but for the physical properties of water, it would, like the intertropical land, lose by radiation into space. It is important to bear this conclusion in mind in any inquiries respecting the influence of the distribution of land and water on general climate, especially as the influence of the land seems to have been hitherto principally considered as a calorific agent.

The heating action of intertropical land has been so often discussed by writers on climate, that it is unnecessary to do more than to point out its principal agency in the production of aerial currents, by which exchanges of temperature may be promoted between different parts of the earth's surface.

In contrasting the mean temperature of the sea with that of the land in tropical climates, the want of nocturnal observations, as referred to by Melloni, is peculiarly felt. While the temperature of the one is nearly constant, that of the other is liable to considerable fluctuations; and, as our records are principally derived from diurnal observations, the results are probably too favorable to an excess of land temperature. This conclusion is confirmed by the results exhibited in Mr. Deville's map, and, in some measure, by the fact of the higher mean temperature of the entire oceanic covering of our planet compared to its atmospheric coating.

In comparing the calorific influence of the land on distant regions with the agency of the sea, it should therefore be remembered, that while the latter stores up heat and acts by night as well as by day, the action of the land is effective only as long as the sun's rays are impinging upon it.

4. Let us endeavor to apply these conclusions to the question of the influence of the distribution of land and water upon general terrestrial temperature. As the amount of solar heat received by any point on the earth's surface is a function of the latitude, it follows that the distribution of land and water at different latitudes must be studied in order to obtain its influence

* Equivalent respectively to 79°·16, 79°·7, 80°·06, and 80°·24 of Fahrenheit's scale.

on temperature. This distribution may be supposed to take place in an endless variety of ways, of which the following three cases are the most important:—

(1.) Preponderance of land towards the poles, and of water towards the equator. (2.) Preponderance of land towards the equator, and of water towards the poles. (3.) Equable distribution of land and water in polar and equatorial regions.

At the present day three-fourths of the earth's surface are covered with water, so that all the dry land has been truly characterized as an assemblage of large and small islands placed in a great ocean. If we suppose, with Sir Charles Lyell,* that in the question now under consideration, the proportion of sea to land is the same as at present, each of the above three cases is susceptible of two principal divisions, according as the islands composing the land happen to be few and large, or numerous and small. If all the dry land on the globe were collected into a single vast continent, the climatological conditions of the earth, all other things remaining the same, would be very different from what would take place if the land were broken up and spread out in numberless islands. Whatever may be the supposed distribution of land and water, it is manifest that its chief influence on the general temperature at the surface of our planet, should result from the action of aerial and oceanic currents.

In the first case above referred to, the belt of equatorial ocean would probably acquire a high temperature, and although the circumpolar islands would possess very rigorous climates in their interior, portions of their coasts might be washed by heat-bearing currents, just as the northwestern coast of Europe is washed by the Gulf Stream at the present day. The superiority of the mean temperature of the ocean might, in this case, be so great that the distribution of heat over the islands should present remarkable instances of the laws found to hold good in the British Isles, and almost all of the isothermals on the land would be closed curves.†

In the second case, the ocean would acquire much less heat from the sun, and it would exercise a cooling influence on the belt of intertropical land. But as whatever evidence we possess seems to indicate that intertropical seas owe their elevated temperature not so much to the influence of thermal exchanges with the air which has passed over the adjacent land, as to the direct influence of sunshine, we may conclude that upon the whole the heat-bearing currents would, in this case, be less influential than in that which has just been considered. The heated air flowing from the equatorial land should, by the agency of winds, in some

* Principles of Geology, chap. vii, 9th ed., p. 101.

† See Atlantis, No. ii, p. 399.

measure mitigate the temperature of the polar regions, but we have no reason for believing that this influence would be superior to that of the heat-bearing water currents in our former instance.

If now we suppose the land to be equally distributed in islands between the equatorial and polar regions, we shall have conditions more or less favorable to the existence of oceanic as well as of aerial heat-bearing currents, and it seems not impossible that, under such circumstances, the entire surface of the globe may enjoy the highest possible amount of general warmth by being best circumstanced for the accumulation, retention, and distribution of the heat it receives from the sun. In this case, as well as in the first which has been considered, warm currents from the equatorial seas might freely bathe the coasts of islands in higher latitudes, thus producing similar characteristic cases of insular climate. The mean temperature of such seas being higher than that of the air over the land, the isothermal lines of the islands should be partly or entirely closed curves, having shapes dependent upon the outlines of the islands. The greater the difference of atmospheric and water temperature, the more strictly should the isothermals conform to this law. Thus it is manifest that a nearly circular island, with a surface equal to that of Labrador, and lying in the same latitude, would present a much greater diversity of climate between its interior and its coasts, if the latter were bathed by sea water having a temperature of 80° Fahrenheit, than if that temperature amounted only to 40°. As the manner in which the warm air over the water would exchange its heat with the air over the land should take place undoubtedly by circulation, it would not be easy to assign a distinct law for the difference of temperature between the interior and the coast of the island; but it seems evident that this difference should, up to a certain limit, increase with the temperature of the heat-bearing oceanic currents. A group of islands situated in high latitudes, and surrounded by currents possessing a high temperature, while receiving but a small amount of heat from sunshine, should present a series of closed isothermals, and while their interiors would be cold, their coasts might enjoy an extremely genial climate.

5. If such conditions existed at former geological epochs, we may fairly expect to find some evidence of their existence by comparing the characters of the organized beings by which the interior and the coasts of such islands were inhabited. Such geologists as have hitherto studied the diversities in structure of the fossil remains which have come under their notice, appear to have attended principally to the climatic influence of the elevation of the interior parts of such islands. Professor Ramsay,*

* Memoirs of the Geological Survey of Great Britain, vol. i, p. 324.

in his memoir on the denudation of Wales, after pointing out the great elevation above the sea, which portions of that region had formerly possessed, calls attention to the resulting varieties of climate that must have prevailed. "If," he says, "the climate of our latitudes, when the coasts were washed by the new, red, and liassic seas, were tropical, as is generally supposed, still on the heights indicated on the vertical sections, we have ample space for tropical and temperate zones, each probably abounding in its own appropriate forms of life. And here, in connection with this subject, it may be remarked, that in Mr. Brodie's recent work, 'A History of the Fossil Insects of the Secondary Rocks of England,' it has been stated that, with certain exceptions, the minute size of the great mass of the insect remains seems to indicate a very cold, or at all events, a temperate climate."

This appeared to Professor Ramsay not to be in harmony with the other fossil evidence, which proves that most of the creatures whose remains are preserved in the strata of the secondary series inhabited a tropical climate. If the interior temperature of the land, whose inhabitants apparently existed under such different conditions of climate, depended not only on the coördinate of height above the sea, but also on that of distance from the coast, in the manner here described, a more complete explanation would be afforded of these remarkable phenomena. The discovery by Mr. Strickland, in the alluvial sand of Worcestershire, of the bones of a hippopotamus, accompanied, not only by the bones of other mammalia, but by twenty-three species of fresh water and land shells, of which nineteen are existing British species, seems to show that, even at a period so recent as that of the deposit from which these remains were taken, remarkable differences of climate may have existed over a comparatively small area of land.* The strong presumptions furnished by the fossil flora, and other evidences connected with the history of earlier geological formations in favor of the existence of numerous islands scattered over an ocean enjoying a tropical temperature, should lead us to expect more of such results as are here noticed, instead of feeling surprise at the discrepancies which they seem to exhibit.

6. I shall now attempt to illustrate some of the preceding general views from the actual condition of the earth's surface. The higher mean temperature of the northern, compared to the southern hemisphere, is clearly proved and universally acknowledged. This superior warmth is usually ascribed to the greater amount of land in the former compared with the latter. It has been apparently assumed that the surface of the dry land exercises upon the whole a far more energetic influence, in tending

* Geological Society's Proceedings, June, 1834, p. 94; and Lyell, p. 76, 9th edition.

to elevate the mean temperature of the earth, than the surface of the water, and this action is generally ascribed to the superior heat-absorbing power of land compared to water. Upon this assumption is mainly founded the beautiful and elaborate theory of geological climates, which Sir Charles Lyell first published in his *Principles of Geology*. Although Fourier had previously indicated the possible influences exercised upon terrestrial temperature by the physical conditions of the earth's outer coating, he had not given his views such a definite shape as to enable him to deduce any conclusions from them for the solution of the great problems of terrestrial physics which have so much occupied the attention of philosophical geologists.

If the conclusions of the theory now referred to be correct, it follows that predominance of land over water between the tropics, where an absorbing surface would be most advantageously circumstanced for acquiring heat, should result in producing the highest possible degree of general terrestrial temperature. On the contrary, the earth's general climate would be reduced to a maximum of coldness by a predominance of land towards the polar regions, and of water towards the equator. The views developed in this essay would appear to require some modification in these conclusions, and the first especially is not in perfect harmony with the results to which we have been led by such reasonings as I have here presented. Not only are there physical grounds for adopting a somewhat different conclusion, namely, that the most favorable condition for a generally high terrestrial temperature would be in a comparatively equable distribution of land and water over equatorial and extratropical regions, instead of a concentration of land in the former; but the study of the present relations of sea and land seems strongly to verify the views on which this conclusion is based.

If we look over a terrestrial globe, or a good stereographic projection of its surface,* we soon perceive that in the regions traversed by the ecliptic, and where, consequently, the sun's rays diffuse the greatest amount of heat over absorbing substances, land and water are distributed very evenly at both sides of the equator. Each hemisphere absorbs the greatest quantity of solar heat during the six months when the sun is vertical over some part of its surface, and I have found that the parallel of 7° 24′ receives the maximum amount of sunshine during the summer half year. In the northern hemisphere this parallel runs from the coast of Guinea through Central Africa; crossing the Indian Ocean, south of Cape Comorin, it passes through Ceylon across Malacca and the island of Mindano; thence through

* M. Babinet's homolographic maps are still better adapted for such comparisons as that now made. See Arago Astronomie, tome iii, p. 344, Report of the British Association for 1856, Trans. Sections, p. 112.

the Pacific, until it meets South America, the northern portion of which it traverses from a point near the Gulf of Panama to another between the mouths of the Orinoco and Esiquibo. In the opposite hemisphere, the parallel of maximum southern sunshine crosses Africa from a point north of St. Paolo de Loando to another near the Monfeca islands. It traverses a great part of Java, New Guinea, and smaller islands. It crosses South America almost on the line of greatest breadth, from near Truxillo to a point north of Pernambuco. On comparing the extent of land and water lying under the parallel of maximum half-yearly sunshine, it appears that the proportions are nearly the same in both hemispheres, although a very slight excess of land appears to lie under the southern, compared to the northern parallel.* Outside the torrid zone, the proportions of land and water belonging to each hemisphere respectively are extremely different: while nearly half of the surface between the pole and the tropic of Cancer is land, by far the greater portion of the area between the southern tropic and the pole is water. In the arctic and antarctic regions land and water alternate in nearly corresponding proportions. The great difference between the areas of land and water of the northern and southern hemispheres exists in the temperate regions. Upon the whole, it may be concluded, that there is a comparative predominance of land over water in the higher latitudes of the northern hemisphere, while the opposite condition holds in the southern hemisphere. If the presence of dry land in high latitudes is favorable to a cold climate, this condition appears to be more completely manifested in the northern than in the southern hemisphere; and if the presence of a certain amount of dry land within the tropics is favorable to a high temperature, that condition is almost equally well fulfilled at both sides of the equator.

Let us conceive all the land north of the equator to be submerged, and its place to be supplied, first, by a mass of land in the north tropical zone, exactly similar in area and configuration to that touching it in the southern zone. Let the arctic regions of North America, Nova Zembla, and Greenland be replaced by an island similar to Victoria Land, and let a few scattered islands replace the greater part of Asia, Europe and North America: we shall then have a globe with a considerable belt of equatorial land, while the polar and temperate regions will be occupied chiefly by water. We should thus have a state of things approximating much more to the conditions required for a high terrestrial temperature than the present distribution of land and water. Yet the distribution here supposed for both hemispheres would be precisely what at present exists in the colder of the

* See p. 328, Art. XXXIV, On the Laws which Regulate the Distribution of Isothermal Lines, § 5.

two; and we should thus have the paradox of warming the entire globe by modelling its warmer hemisphere after its colder. Unless the influence of Victoria Land as a refrigerator of the southern hemisphere should be greater than that of the immense masses of land in the northern parts of the new and old continents, this paradox would seem inexplicable on the theory under consideration. But it can be in some measure explained, if the agency of oceanic currents in storing up and transporting the heat acquired from sunshine be fully admitted. In the actual state of the earth's surface, the form of the basin of the South Atlantic Ocean, combined with other physical conditions, seems to determine the transfer of a great volume of heated water from the southern intertropical regions to the northern hemisphere, which, passing subsequently through the Caribbean Sea and Gulf of Mexico, acquires a still higher temperature, and ultimately confers its warmth on regions in high northern latitudes. From the direction of the currents of the Pacific, as laid down on some of Maury's charts, it is probable that a similar transfer northwards of heated southern intertropical water is effected in that great ocean as well as in the Atlantic. The general result is, that the southern hemisphere is not only deprived of a certain amount of the solar heat absorbed by its waters, but that the temperature of the northern hemisphere is augmented to a corresponding amount. But although the paradox alluded to may be thus explained, this result shows the danger of underestimating the agency of aqueous currents in connection with any theory of the distribution of land and water that may be proposed in order to explain vicissitudes of terrestrial climate.

7. In examining the consequences resulting from the suppression of the Gulf Stream on the climate of western Europe, with reference to the question of glacial action at former geological epochs, as has been done by Mr. Hopkins,* we need only direct our attention to what actually takes place at corresponding latitudes in the southern hemisphere. In these regions, there is not only an absence of such an active calorific agent, but even an abstraction of some of the heat due to them from the sunshine which falls upon a portion of their oceans, which heat we have seen is transferred to the northern hemisphere. Glaciers consequently descend to the sea, not only about the latitude of 54° S., as observed by Captain Cook, but even so close to the equator as 48° 30′ S., where they were noticed in great abundance on the western coast of South America by Mr. Darwin.† He even observed one instance of a glacier reaching the sea in the latitude of 46° 40′, which corresponds to that of Napoleon Vendée, in the west of France. The existence of glacial action in the

* Quarterly Journal of the Geological Society, 1852, p. 85.

† Voyage of Adventure and Beagle, iii, p. 282.

southern latitudes, equivalent to those of the temperate regions of western Europe, suggests the possibility, that by an inversion of the operating causes, the southern hemisphere might have enjoyed a milder climate at the same geological period when glacial phenomena were most completely developed north of the equator.

8. The results of our inquiry may be thus recapitulated:—

(1.) The physical properties of water appear upon the whole more favorable than those of the land, to the accumulation, retention, and distribution of solar heat throughout the matter composing the external coating of the earth.

(2.) Phenomena presented by intertropical seas at the present day, confirm and illustrate this conclusion.

(3.) The distribution of land and water most favorable to a general increase of terrestrial mean temperature, should, therefore, be such as would imply the existence of great intertropical seas and of groups of islands evenly distributed both within the tropics and in extratropical regions.

(4.) Such a distribution of land and water at former geological epochs, seems to be indicated by the results of observation.

(5.) The superior mean temperature of the northern compared to the southern hemisphere is probably due, not to the direct influence of the greater proportion of land in the former, but to currents which determine the transfer towards the north of a portion of the solar heat absorbed south of the equator.

9. While fully acknowledging the important influence which changes in the distribution of land and water may exercise on terrestrial climate, we are not precluded from studying the action of other causes, and of giving to them such weight as the evidences in their favor may render advisable. If, from the results of astronomical as well as of geological testimony, we are induced to believe that the earth has been for ages slowly cooling from a state of former incandescence, its climate during the earlier epochs of its physical history must have been more or less influenced by the heat thus passing outwards through its crust. However efficient, as applied to recent phenomena, we may find the theory of geological climates that explains the variations of the earth's superficial temperature by changes in the distribution of the liquid and solid portions of its outward coating, it seems by itself incompetent to rationally and consistently account for the very high temperature which must have prevailed during remote epochs of the earth's history. If we reject the evidence on which it has been concluded that the earth has slowly cooled from a fluid incandescent state into its observed condition, and admit that the earth's spheroidal shape was due to gradual and even existing causes, and not to the mechanical consequences of its primitive and universal fluidity, we shall arrive at a conclu-

sion which, on the supposition of the complete adequacy of superficial causes to explain all changes of climate, would lead to the inference that, from very remote epochs, the mean temperature of the globe should be increasing instead of diminishing. By rejecting the former fluid condition of the earth, we are compelled to account for its oblateness in the way attempted by Playfair, that is, by appealing to the influence of certain superficial actions coexisting with the phenomena of geological changes. But I have proved,* that if, from superficial causes, the earth's figure became gradually more oblate, the extent of polar dry land would gradually diminish, while that of equatorial dry land would, at the same time, tend to augment. Hence the very operations required to mould the earth's figure into the shape now observed, would, on this theory, point to a gradual increase in the efficiency of the physical conditions required for an augmentation of terrestrial temperature in proceeding from the most remote to the most recent geological epochs. But this is the very reverse of the conclusions deduced from the entire mass of geological inquiries; hence, as far as observation enables us to judge, we cannot explain by superficial actions alone, the twofold conditions of the spheroidal shape in the earth's figure, and the gradual diminution of its surface temperature from the earliest periods of geological history up to the most recent.

ART. XXXIV.—*Note on the Laws which Regulate the Distribution of Isothermal Lines;* by HENRY HENNESSY, F.R.S., M.R.I.A., Professor of Natural Philosophy in the Catholic University of Ireland.†

IN my essay on the Distribution of Heat over Islands,‡ I referred to another mode of treating the general problem of isothermal lines, by which similar conclusions are derived. As these conclusions are not only obtained by a method somewhat different from that already published, but as they are accompanied with a few additional remarks relative to their connection with the climatology of the globe, I may be permitted to present the following investigation as a development of a portion of the former inquiry.

2. The general problem, whose solution is here attempted, is to find the influence exercised by the physical structure and hydrographical relations of an island on the temperature at its surface. Let us consider an island having a certain definite figure,

* Proc. Royal Irish Academy, vol. iv, p. 333, and Journal of the Geological Society of Dublin, March, 1849.

† Cited from the Atlantis for January, 1859. ‡ Atlantis, vol. i, p. 399.

and surrounded by an ocean so warm that we may at first neglect the influence on its climate of the difference of latitude of the several parts of its surface. Let it be supposed perfectly free from hills or mountains, land breezes will tend to blow from the interior, and sea breezes from every point on the coast. The disturbing action of other winds would sometimes greatly modify the directions and intensities of the land and sea breezes; but, abstracting for a moment the effect of such general winds, it is evident that the temperature at any point of the island due to the action of the warm air flowing in from the ocean, and of the cold air flowing from the interior, will be some function of its distance from the coast, and, consequently, the forms of the isothermal lines should have some relation to the coast line. If no other winds blew over the surface of the island but land and sea breezes, and these with uniform intensity and frequency at every point, the isothermal lines should be similar to the coast line. Let us now superimpose on the island a series of elevations sufficiently considerable to offer impediments to the currents of wind: the forms of the isothermal lines will undergo important changes. If these eminences are scattered around the coast, their influence shall be greater than if they were all concentrated towards the interior of the island; for, in the former instance, they will present a kind of barrier, more or less broken, between the air resting on the central plains and the air outside covering the ocean. The sea breezes will no longer exercise the same effect on the portions of the interior situated behind the mountains, while their influence will remain unchanged, or be even increased, on the portions still unscreened from the ocean. A corresponding change must, therefore, take place in the forms of the isothermal lines. They should approach the coast at the parts screened by the mountains, while they should remain stationary, or sometimes recede towards the interior, at the intervals between the mountains. If the interior of the island does not consist entirely of dry plains, but is covered with lakes and considerable areas of undrained marshy land, such evaporating surfaces will cool the surrounding air. If the evaporating surfaces be concentrated chiefly about the centre of the island, their influence will not be much felt at the coast, and thus, although they may produce some local changes in the forms of the isothermal lines in their neighborhood, their most important effect will be to render still more decisive the differences of temperature on a line drawn from the coldest region at the centre to the coast; in other words, to contract or enlarge the dimensions of some of the isothermals.

3. If the influence of the differences of latitude of the surface of the island be now considered, it can be demonstrated that its

tendency will be to transport the centres of the isothermals towards the pole, in whatever hemisphere the island may be situated, and that the isothermals at the centre shall be more affected from this cause than those at the coast. Let us suppose, for precision, the island in the northern hemisphere.

Let us at first abstract the effect of all other sources of terrestrial temperature but solar radiation, and consider the proportions of heat that may be received by two elements of the surface of the island included between two adjacent isothermal lines. It will suffice to determine the quantities for the spaces included between each of their northern and each of their southern extremities respectively. From the great distance of the sun, its rays may be supposed nearly parallel, and from the limited area we are considering, the earth's figure may be supposed perfectly spherical. By the laws of radiant heat, the amount of heat received by an element s of the surface of the earth, will be represented by*

$$\frac{s\,G\cos\varphi}{R^2}.$$

G being a coefficient, independent of the state of the earth's surface, and expressing the amount of heat that passes from the sun to a unit of surface placed perpendicularly to the direction of the sun's rays at a certain unit of distance, φ the inclination of the sun's rays to a perpendicular to the plane of the element s of the earth's surface, and R the radius of the earth's orbit. But

$$s = a^2\cos\lambda\,d\lambda\,d\mu,$$

where a is the earth's radius, λ the latitude of the point where the element s is situated, and μ its longitude. But in the spherical angle whose sides $\frac{\pi}{2}-\delta$, $\frac{\pi}{2}-\lambda$, include the angle ψ, which subtends φ, we have

$$\cos\varphi = \sin\lambda\sin\delta + \cos\lambda\cos\delta\cos\psi,$$

where δ is the sun's declination, and ψ an angle depending on the hour of the day, being included between the meridian of the element and that of the sun. The problem now before us, being connected with the proportional quantities of sunshine received by different elements and not with the absolute amounts, we may in a first approximation consider these quantities as proportional to the amount received at noon; consequently for a limited area of the sphere the quantity of heat received in the time dt is proportional to

$$\frac{G\,a^2}{R^2}\iiint\cos(\lambda-\delta)\cos\lambda\,d\lambda\,d\mu\,dt.$$

* Poisson Théorie Mathématique de la Chaleur, No. 210.

But if u represents the mean longitude of the sun, and P the parameter of the earth's orbit, we should have

$$R^2 du = \sqrt{P}\, dt.$$

But also

$$\sin\delta = \sin i \sin u,$$

i being the inclination of the equator to the ecliptic: therefore the above expression becomes

$$\frac{a^2 G}{\sqrt{P}} \left\{ \iiint \cos^2\lambda \sqrt{1-\sin^2 i \sin^2 u}\, du\, d\lambda\, d\mu \right.$$
$$\left. - \iiint \sin i \sin u \sin\lambda \cos\lambda\, du\, d\lambda\, d\mu \right\}$$

The limits between which the integrations for μ and λ are to be effected, will depend on the figure of the surface under consideration. For simplicity, let it be an extremely small portion of the surface of the island included between two meridians, so close to each as to include a nearly rectangular space between their segments and those of the two isothermal lines. If m be the breadth of the rectangle, we may take μ from o to m, and λ from λ_2 to λ_1, λ_1 being the latitude of the northern extremity of whichever of the isothermals is nearest the coast, and λ_2 the latitude of the northern extremity of the other isothermal. The area under consideration will be $m(\lambda_1 - \lambda_2)$. The sun's longitude u must be taken from 0 to 2π in estimating the amount of solar heat received during a year.

4. The heat received by the element $m(\lambda_1 - \lambda_2)$ from the influences of causes, independent of direct solar radiation, will, as already stated, be a function of the distance of this element from the coast; it will therefore be a function of the difference of its latitude and that of the nearest point on the coast. If we make $\lambda_1 + \lambda_2 = 2A$, and represent the latitude of the northern part of the coast nearest the element of surface by l, we shall have for H the proportion of heat received by the element during a year, the expression

$$H = f(l - A)$$

$$\frac{a^2 G m}{2\sqrt{P}} \left\{ \left[\tfrac{1}{2}(\sin 2\lambda_1 - \sin 2\lambda_2) + \lambda_1 - \lambda_2\right] \int_0^{2\pi} \sqrt{1-\sin^2 i \sin^2 u}\, du\, du \right.$$
$$\left. - \tfrac{1}{2}(\cos 2\lambda_2 - \cos 2\lambda_1) \sin i \int_0^{2\pi} \sin u\, du\, du \right.$$

The second of these integrals vanishes between the limits, and the first may be determined by the properties of elliptic functions for

$$\int_0^{2\pi} \sqrt{1-\sin^2 i \sin^2 u}\, du\, du = 4 \int_0^{\frac{1}{2}\pi} \sqrt{1-\sin^2 i \sin^2 u}\, du\, du$$
$$= 4\, E(i).$$

$E(i)$ representing a complete elliptic function of the second order,* whose modulus is i. The value of i being 23° 28, $E(i)$ $=1{\cdot}50658$: consequently we may ultimately write

$$H=f(l-\Lambda)$$
$$-3{\cdot}01316\frac{a^2G}{\sqrt{P}}m\left\{\sin(\lambda_1-\lambda_2)\cos(\lambda_1+\lambda_2)+\lambda_1-\lambda_2\right\}$$

But as $\sin(\lambda_1-\lambda_2)=\lambda_1-\lambda_2$, very approximately, this may be written,

$$H=f(l-\Lambda)+C(1+\cos 2\Lambda)$$

where

$$C=3{\cdot}01316\,a^2G\frac{m(\lambda_1-\lambda_2)}{\sqrt{P}}.$$

Similarly H_1 the proportion of heat received by the very small and nearly equal area included between the southern extremities of the isothermals, may be written

$$H_1=f(l_1-\Lambda_1)+C_1(1+\cos 2\Lambda_1)$$

where

$$C_1=C\frac{(\lambda_3-\lambda_4)}{\lambda_1-\lambda_2}, \qquad 2\Lambda_1=\lambda_3-\lambda_4$$

and $l_1=$ the latitude of the nearest point of the southern coast of the island. $f(l-\Lambda)$ and $f(\Lambda_1-l_1)$ are both positive, and both are supposed, in virtue of what has been already stated, to possess the property of varying inversely with $l-\Lambda$ and Λ_1-l_1 respectively; in other words, $f(l-\Lambda)$ increases when $l-\Lambda$ diminishes, and $f(\Lambda_1-l_1)$ increases when Λ_1-l_1 diminishes. If we divide H and H_1 by the nearly equal areas $m(\lambda_1-\lambda_2)$ and $m(\lambda_3-\lambda_4)$ respectively, the results will represent the amount of heat received by the units of surface at the northern and southern extremities of the isothermals. These quantities should be equal; hence we shall have, very approximately,

$$\cos 2\Lambda+f(l-\Lambda)=\cos 2\Lambda_1+f(\Lambda_1-l_1);$$

But as $\cos 2\Lambda<\cos 2\Lambda_1$, it follows that $f(l-\Lambda)>f(\Lambda_1-l_1)$, and, consequently, $l-\Lambda<\Lambda_1-l_1$. If the influence of solar radiation were not considered, these quantities would be equal: consequently its tendency is to transport the closed isothermal line from south to north, by making the distance of its northern extremity from the northern coast less than the distance of its southern extremity from the southern coast. The same result will affect the next adjacent isothermal, and so on in succession, so that ultimately all the isothermal lines will be transported towards the north.

As

$$C(1+\cos 2\Lambda)=2C\cos{}_2\Lambda,$$

* Poisson gives 0·17798, as its logarithm from Legendre, Théorie de la Chaleur, p. 490.

the heat received at any point of the earth's surface from solar radiation alone, abstracting the influence of atmospheric absorption in different latitudes, varies in conformity with Mayer's law as the square of the cosine of the latitude.

The more the influence of latitude predominates over all other causes, the more will the positions of the isothermals be changed in the manner above indicated: it follows, therefore, that while towards the equatorial coast of an island these lines terminate on the coast, they may still continue as closed curves in the interior of the island. If the influence of differences of latitude was greatly predominant over all other climatic influences, all the isothermals may terminate on the coast.

5. The quantity of heat received by a given small area during the summer and winter half-years, between the spring and autumnal equinoxes, may be readily found by integrating with respect to u, within the limits 2π and π, and afterwards within the limits π and 0. Thus we shall have the general expression

$$\frac{a^2 G m}{P^{\frac{1}{2}}} \left\{ [\cos(\lambda_1+\lambda_2)\sin(\lambda_1-\lambda_2)+\lambda_1-\lambda_2]\, E(i) \right.$$
$$\left. \pm 2\sin i \sin(\lambda_1+\lambda_2)\sin(\lambda_1-\lambda_2) \right\} \qquad (4.)$$

the term affected by $2\sin i$ is to be taken with the positive sign for that half of the year during which the sun is at the same side of the equator as the area in question, and the negative sign for the other half of the year. If $\lambda_1-\lambda_2$ be so small that its square may be neglected, then for the small area $s = m(\lambda_1-\lambda_2)$ we shall have the amount of solar heat H_1 received during either half year expressed by the equation

$$H_1 = K(E(i)\cos^2 A \pm \sin i \sin 2A), \text{ making } K = \frac{2a^2 G s}{P^{\frac{1}{2}}} \qquad (5.)$$

$\sin 2A$ is always positive, as A cannot exceed 90°, it follows, therefore, that the influence of latitude on the points of the isothermals will be greater during the summer half of the year than during the winter half; and therefore, all other things remaining the same, the isochimenal lines, or lines of equal winter temperature, would be less displaced from their concentric position in an island than the isotheral lines, or lines of equal summer temperature.

From the preceding expression we can determine the latitude of the parallel which receives the greatest amount of solar heat during the summer half of the year. For on differentiating we have

$$\frac{dH}{dA} = K(\sin i \cos 2A - E(i)\sin 2A),$$

This equated to zero gives

$$\text{tang. } 2A = \frac{\sin i}{E(i)} \qquad (6.)$$

Also, $$\frac{d^2 H}{dA^2} = -2K\left\{\sin i \sin 2A + E(i)\cos 2A\right\}$$

If in (6) we substitute the values of $E(i)$ and $\sin i$ respectively, we shall find $A = 7^\circ\ 24'$ nearly, $\cos 2A$ and $\sin 2A$ will both be positive, and therefore $\frac{d^2 H}{dA^2}$ negative; the above value of tang. $2A$, gives therefore a maximum value to H, and consequently the parallel which receives the greatest amount of solar heat during the half year that the sun is at the same side of the equator, is the parallel which has the latitude $7^\circ\ 24'$.

6. The results of these investigations become applicable to the two great continents of the eastern and western hemispheres; for as these are both completely surrounded by water, they may be considered as two immense islands. The distance from the ocean of the greater part of their surfaces, diminishes so much the action on their general climate of the waters by which they are surrounded, that the influence of difference of latitude becomes as a general rule, predominant over all other causes, and the centres of most of their isothermal lines are transported so far towards the pole, that many of these lines circumscribe the earth's axis, or lie in surfaces which cut that axis more or less obliquely.

In the interior of a continent, an elevated table-land of limited dimensions is circumstanced nearly in the same way as an island, for its edges are surrounded with air having a mean temperature nearly uniform, and different from that lying on its surface. We may therefore expect to find, even in the interior of continents, closed isothermal lines, as well as in the interior of oceanic islands.

The disturbing action of general winds will modify the forms of the isothermal lines, according to the frequency and the temperature of these winds. The warm winds will cause the isothermals to recede from the coast towards the interior in a direction opposed to that from which they emanate; the cold winds will, on the contrary, cause the isothermals to advance towards the direction from which they blow. We may, therefore, conceive the tendency of such general winds, when warm, to be to remove the centres of the isothermals from the points whence they blow; when cold, their tendency will be to approach these centres towards the same points. If we compound these tendencies with the effect of differences of latitude, we would have the resultant direction towards which the isothermal lines should be displaced from their concentric position by the action of all these disturbing causes.

ART. XXXVI.—*On the possible Intersection of the orbits of Mars and certain of the Asteroids;* by Professor DANIEL KIRKWOOD, of the Indiana University.

THE present eccentricities of the asteroidal orbits are included between the limits 0·046085 and 0·336987. Of these, some are increasing, others diminishing. We are not aware, however, that the range of variation has, in any instance, been accurately determined. If we assume the superior limit of the eccentricity, in the case of the following members of the group, to be 0·25, (and this is less than the *present* eccentricity of Juno, Phocæa, Polyhymnia, and Atalanta,) their perihelion distances at the epochs of maximum eccentricity will be as follows:

Flora,	1·650940
Ariadne,	1·652879
Harmonia,	1·700361
Melpomene,	1·722045.

The present *aphelion* distance of Mars is 1·665725, the eccentricity of the Martial orbit is, however, increasing; the secular variation being 0·000090176. According to LeVerrier the maximum eccentricity will be 0·14224. The corresponding aphelion distance will be 1·740431; greater than the *least* perihelion distances of the asteroids above named. It is obvious therefore that if the longitudes of Mars and any one of these bodies should differ by nearly 180° when the eccentricities of both are not far from their superior limits, the orbits or at least their projections on the plane of the ecliptic, *must intersect.* When it is remembered that the variation of the eccentricity is extremely slow, that the line of apsides of the orbit of Mars completes a revolution in less than 20,000 years, aud that the inclinations of the orbits of Flora, Harmonia and Ariadne, are small, the probability of a very near approach of Mars and some of these small planets—an approach so close as to render the question of the perturbations of the latter both curious and interesting—is at once apparent. If we assume the greatest eccentricity *now* found in the group, as the superior limit of the variation of *all*, the maximum *aphelion* distance of Mars will be greater than the minimum *perihelion* distances of twenty of the small planets.

Bloomington, Ind., Feb. 11, 1859.

ART. XXXVII.—*Contributions to the History of Euphotide and Saussurite;* by T. STERRY HUNT, of the Geological Survey of Canada.

1. The name of euphotide was originally given by Haüy to a rock composed of diallage and a white compact mineral which he designated as *feldspath tenace*, (the compact feldspar of Werner, the lemanite of Delamétherie, and the jade of de Saussure senior). The well-marked contrast of colors which suggested the name of euphotide is seen in the beautiful *verde di Corsica* or *verde antico di Orezza*, and in some varieties of the rock from Mt. Rose. In these the diallage is represented by a grass-green smaragdite, and this mineral and hypersthene being regarded by Haüy as varieties of diallage, he included under the head of euphotide, the *verde di Corsica*, (for which alone d'Halloy retains the name of euphotide,) the hypersthenite or hyperite of other authors, and the granitone of the Italians. This last by an error of Von Buch, in which he has been followed by Gustav Rose, is very frequently called gabbro. The true gabbro of the Italians is however a diallagic ophiolite. (Brongniart, *Classif. des Roches*, 1827, p. 75.)

Brongniart defines euphotide to be a mixture of diallage with jade, petrosilex, or compact feldspar, and including d'Halloy's two species, euphotide and granitone, but excluding hyperite, he distinguishes as varieties, jadian and feldspathic euphotides, besides ophitic (serpentinous) and micaceous euphotides, the latter being sometimes talcose.

Coquand (*Traité des Roches*, 1857,) has followed Haüy with regard to the euphotides, while Senft (*Die Felsarten*, 1857,) places in one group, under the head of hyperite, three genera, eclogite, gabbro, and hypersthenite, in the second of which he includes rocks made up of labradorite or saussurite with diallage or smaragdite. The eclogite of Haüy is composed of diallage or smaragdite, and red garnet; it often holds disthene (cyanite) through the predominance of which it passes into disthenite (disthenfels), while hypersthenite or hyperite (hypersthenfels, G. Rose) is a mixture of saussurite or labradorite with hypersthene (d'Halloy, Senft.).

Distinctions like some of the above based upon the contained varieties of pyroxene are evidently of secondary importance, and it becomes necessary to define with more strictness the nature of the other element of the rocks in question. The jade of the Swiss Alps to which de Saussure junior, afterwards gave the name of saussurite, was described by de Saussure senior, as compact, tenacious, greenish-white in color, hard enough to scratch quartz, and having a specific gravity of 3·318—3·389.

Mohs gives 3·256 for the density of a granular saussurite from Peidmont, and 3·34 for a compact variety from the Canton of Vaud, while Naumann assigns to the mineral a density of 3·40. These authors thus agree in ascribing to saussurite a specific gravity much above that of the feldspars.

Klaproth and de Saussure junior, both analyzed specimens of the saussurite from the shores of the Lake of Geneva (lemanite, I and II) while Boulanger subsequently examined the saussurite from the euphotide of Mt. Genèvre (III), and from two localities in Corsica, the valley of Orezza (IV) and the banks of the Fiumalto (V).

	I.	II.	III.	IV.	V.
Silica,	49·00	44·00	44·6	43·6	34·0
Alumina,	24·00	30·00	30·4	32·0	24·4
Peroxyd of iron,	6·50	12·50	....	....	....
Lime,	10·50	4·00	15·5	21·0	31·8
Magnesia,	3·75	....	2·5	2·4	6·4
Soda,	5·50	6·00	7·5	....	....
Potash,	....	·25	....	1·6	....
	99·25	96·75*	100·5	100·6	96·6

The physical and chemical characters of the above specimens offered considerable differences. The saussurite II. is described by de Saussure as leek-green, subtranslucent, with an oily lustre, and a finely granular, scaly fracture; it scratched quartz and had a density of 3·261. At a high temperature it fused without loss of weight, into a glass much softer than the original mineral, and having a density of only 2·8. This saussurite, which was free from any admixture of smaragdite, was scarcely attacked by boiling sulphuric acid.—(*Journal des Mines*, vol. xix, p. 205, A. D. 1805.)

The saussurite from Mt. Genèvre (III) according to Boulanger is associated with a greenish-brown smaragdite, and is itself greenish-white and compact, not scratched by the knife, and having a density of 2·65. He describes another euphotide from the same locality as having a lamellar base, with cleavages like feldspar, sometimes chatoyant, hard, not attacked by acids, and with a density of 2·58. The analysis of this undoubted feldspar gave him, silica 66·6, alumina 18·5, lime 1·8, soda 6·0, potash 4·3 = 97·2.

The euphotide of Orezza is described by Boulanger as composed of green diallage, a blackish matter also apparently a variety of diallage, and saussurite, the whole arranged in parallel bands, giving to the mass, which is very tough, a schistose fracture. The saussurite (IV) was very compact, less hard than III, and had a density of 3·18. It was easily fusible and not attacked by concentrated sulphuric acid.

* Besides 0·05 oxyd of manganese.

The euphotide of the Fiumalto consisted of green diallage with curved lamellæ in a white paste, which was tender, easily cut with a knife, and had a density of 3·30 (v). It was readily fusible and easily attacked by sulphuric acid, with which the analysis was made; the separated silica being dissolved by a solution of potash which left a residue, supposed to be diallage, and equal to 3·8 parts, which added to the above analysis makes the sum 100·4; alkalies were absent.—(*Ann. des Mines*, [3], viii, p. 159.)

Notwithstanding the peculiarities presented by saussurite, modern mineralogists have generally referred it to labradorite or some other feldspar, (see Beudant, Bischoff, Dana, Delesse, etc.). Jameson, separates it from the feldspars on account of its greater specific gravity, but recent authors seem to have entirely lost sight of this characteristic. Coquand describes saussurite as having a density of 2·87, while according to Delesse it is seldom inferior to 2·80. These authors agree in declaring the mineral to be decomposable by acids like labradorite, while Bischoff and Senft, without alluding to its density, assert that saussurite is not attacked by acids.

An analysis of saussurite by Stromeyer gives the composition of labradorite, while Lory on the other hand has described as euphotide a rock from Levaldens in the Dauphinese Alps, which is made up of an olive hornblende and a white mineral having the cleavage of a feldspar and the composition of andesine. —(*Bull. Soc. Geol. de France*, [2], vii, 540.)

Delesse examined the white base of a euphotide from Odern in the Vosges, and another from Mt. Genèvre. Both of these were highly crystalline and exhibited the polysynthetic macles of the feldspars of the triclinic system. When pulverized and treated with muriatic and sulphuric acids they swelled up and were decomposed. Delesse has however described them as saussurite. That from Odern gave him, silica 55·23, alumina 24·24, lime 6·86, magnesia 1·48, protoxyd of iron 1·11, soda 4·83, potash 3·03, water and volatile matters 3·05 = 99·83. The euphotide of Mt. Genèvre contained diallage, a serpentine-like substance, and a ferriferous carbonate of lime, besides the feldspar, whose crystalline laminæ were more than one-third of an inch in length, and gave by analysis, silica 49·73, alumina 29·65, lime 11·18, magnesia 0·56, protoxyd of iron 0·85, soda 4·04, potash 0·24, water and volatile matters 3·75 = 100·00. Of the volatile portion according to Delesse, at least 2·50 p. c. is water, the remainder being carbonic acid. (*Ann. des Mines*, [4], xvi, pp. 238 and 267.) This feldspar resembles that of the orbicular diorite of Corsica which gave to Delesse, silica 48·62, lime 12·02, alkalies 3·61, and 0·49 of water.

Under the name of saussurite von Rath has described a mineral which with hornblende (uralite) forms the greenstone of Neurode in Silesia. It had the hardness, cleavage, and crystalline structure of labradorite, but with a specific gravity of 2·99, and gave by analysis, silica 50·84, alumina 26·00, peroxyd of iron 2·73, lime 14·95, magnesia 0·22, potash 0·61, soda 4·68, volatile 1·21 = 101·24.—(*Pogg. Ann.*, xcv, 555.)

2. Accepting the view maintained by Rose, Bischoff and Delesse, that saussurite is nothing more than a feldspar, I referred to this species the compact feldspars of the Laurentian rocks of Canada, described in my report of 1854. Associated with the limestones and ophiolites of this most ancient geological series, is a great body of crystalline stratified rocks, composed essentially of anorthic feldspars, sometimes almost without admixture, but frequently associated with green granular or cleavable pyroxene, which passes through a kind of bronzite into hypersthene. Small quantities of epidote, garnet, and more rarely mica and quartz, are also met with, and magnetite and ilmenite are common. Different varieties of these rocks would be referred by lithologists to the species labradophyre, dolerite, and euphotide. The feldspars are sometimes very coarsely crystalline but often compact; they have a hardness of 6·0, and vary in density from 2·67 to 2·73, and in composition from andesine to vosgite. The denser varieties are those in which lime and alumina predominate; all of them contain besides soda small quantities of potash. The analyses of numerous varieties of these feldspars will be found in the Report cited above, and in the *L. E. and D. Philos. Magazine*, [4], ix, 262.

The euphotides examined by Delesse and Lory are apparently nothing more than varieties of dolerite, by which term we understand a rock composed essentially of a triclinic feldspar, with some variety of pyroxene, which may be augite, hypersthene, or diallage. According to G. Rose, smaragdite, which is the variety of pyroxene regarded as characteristic of euphotide, has often the external form of pyroxene with the cleavage of hornblende, constituting the variety uralite, while in the euphotides of Baste and Veltlin hornblende occurs with the diallage, and sometimes replaces it entirely, giving rise to a rock composed of saussurite and hornblende. Sandberger has observed crystals of pyroxene forming macles with others of hornblende, and the latter often surround the crystals of pyroxene, or as I have remarked in specimens from Madawaska, small crystals of deep green hornblende are implanted upon large prisms of greenish-white pyroxene. Smaragdite according to Hisinger and Delafosse consists of laminæ of pyroxene and hornblende united in a more or less regular manner. Since diorite is distinguished from dolerite by the substitution of hornblende for pyroxene, it

is evident that feldspathic aggregates like those of Baste present a transition from the one to the other species of rock.

Diorite is distinguished from diabase according to Senft by containing a feldspar insoluble in acids (albite or oligoclase,) and by the frequent presence of quartz, while in diabase the feldspathic element is less silicious and decomposable by acids; (labradorite or a variety approaching anorthite).* When however we consider the manner in which these feldspars pass into one another, this distinction between diorite and diabase seems of but secondary importance. We have seen that the orbicular diorite (or diabase) of Corsica contains a feldspar near anorthite in composition, while others in the Vosges, according to Delesse, contain labradorite and andesine, the latter with quartz. Lory has described a diorite from the crystalline schists of the mountains of Chalanches (Isère) which is made up of a chromiferous hornblende, with crystalline andesine and a pale greenish-yellow epidote often intimately mixed with the feldspar, and so abundant as to characterize the rock. This epidote gave by analysis, silica 40·6, alumina 30·2, lime 17·7, protoxyd of iron 11·2 = 99·7.

3. Diorites, as already mentioned, sometimes contain albite. Associated with the Silurian ophiolites of Canada we often find beds of rock which are mixtures of albite with hornblende or pyroxene, sometimes with small portions of carbonates. These diorites are tough, granular, sub-translucent, greenish or bluish-gray in color, weathering superficially to an opaque white and having a somewhat waxy lustre. Hardness 6·0; density 2·71—2·76. The hornblendic element is sometimes nearly amorphous, but at other times forms cleavable grains; by ignition these portions become darker, while the feldspar is rendered whiter and more opaque, and often exhibits striæ upon the cleavage surfaces.

A fine grained variety of this diorite from Orford was examined; it had a somewhat yellowish-green color and a subconchoidal fracture. After ignition the striated crystalline grains of feldspar were distinctly seen. The powdered rock does not effervesce with nitric acid, which appears to be without action upon it. The analysis gave as follows:

			Oxygen.
Silica,	63·60	63·40	33·81
Alumina,	12·70	12·70	5·93
Soda,	7·95	8·08	2·07
Potash,	·13		
Lime,	7·28	7·50	4·43
Magnesia,	3·37	3·37	
Protoxyd of iron,	4·23	4·23	
Loss by ignition,	·40	·40	
	99·68	99·68	

* See R. H. Scott, *L. E. and D. Phil. Mag.*, [4], xv, 518.

The oxygen ratios of the alkalies and alumina in the above analysis are very nearly as 1 : 3, and if to these we add the silica corresponding to twelve equivalents, or in round numbers to 24·00 of oxygen (equal to 45·00 of silica) we shall have 65·78 parts of albite, in which the oxygen ratios are 1 : 3 : 12. The oxygen of the remaining silica and protoxyds equal 9·81 : 4·43, showing a slight excess of silica over the proportion required to form a pyroxene.*

The feldspathic base of dioritic and doleritic rocks is sometimes even more silicious than albite, and passes into petrosilex, which may be regarded as a mixture of feldspar with quartz, or perhaps a distinct feldspar like krablite. Brongniart mentions petrosilex as sometimes forming the base of euphotide, and Thompson has described under the name of saussurite a mineral which occurs with diallage at the Lizard in Cornwall, having a density of 2·80, and yielding by analysis 82·0 p. c. of silica, besides alumina, lime, magnesia and oxyd of iron. In this connection I may cite from my report above referred to, the analyses of two varieties of petrosilex. The first (A) forms great beds among the ophiolite rocks of Orford; it is apparently homogeneous, somewhat translucent, very tough and with a scaly conchoidal fracture; it is distinguished from the diorites just described by the absence of the white opaque coating upon the weathered surfaces. Color greenish or grayish-white; lustre waxy, dull. Hardness 6·0; density 2·635—2·639. The second (B) from St. Henri, is a finely granular greenish rock, which occurs interstratified with shales and limestones in unaltered Silurian strata which are regarded as the equivalents of the ophiolitic series. It is somewhat less compact and tenacious than the last, which however, it closely resembles.

	A.	B.
Silica,	78·40	71·40
Alumina,	11·81	13·60
Soda,	4·42	3·31
Potash,	1·93	2·37
Lime,	·84	·84
Magnesia,	·77	2·40
Protoxyd of iron,	·72	3·24
Loss by ignition,	·90	2·50
	99·79	99·66

4. While engaged in the examination of the various feldspathic rocks which are associated with the ophiolites of Canada, I was constantly looking for some mineral whose hardness and specific gravity should correspond to those of the jade or saussurite of

* See for further analyses the Report of Geol. Survey of Canada for 1856, p. 453, in which the above analysis is calculated for the old equivalent weights of silica. In the present paper the equivalent of SiO_2, has been reckoned at 14+16 =30.

de Saussure and Mohs. At length I met with a very heavy rock which occurs with the ophiolites of Orford, and closely resembles an ophitic euphotide. It is made up of a white garnet having the aspect of saussurite, intermingled with a small amount of a soft green serpentine, which fills the interstices between irregular rounded masses of the garnet; portions of the latter mineral half an inch in diameter, are easily obtained in a state of purity. It is distinguished by a hardness of 7·0, and by its density, which for selected fragments, was found to be 3·522—3·536. It is amorphous, finely granular, and extremely tenacious, with a conchoidal fracture; lustre feeble, waxy; color yellowish or greenish-white; sub-translucent. After intense ignition, which did not however effect its fusion, the pulverized mineral gelatinized with hydrochloric acid. Its analysis was made after fusion with carbonate of soda, and gave:—

Silica,	38·60	38·80
Alumina,	22·71	
Lime,	34·83	
Magnesia,	·49	
Oxyds of iron and manganese,	1·60	
Soda and a trace of potash,	·47	
Loss by ignition,	1·10	
	99·80	

This mineral agrees closely in composition and properties with lime-alumina garnet, whose theoretical composition is represented by silica 40·1, alumina 22·7, lime 37·2 = 100·0. Croft obtained for a white garnet from the Ural mountains, having a density of 3·504: silica 36·86, alumina 24·90, lime 37·15 = 98·10.

At the falls of the river Guillaume in St. François, (Beauce,) there is also found a heavy rock which is composed in great part of garnet. It forms a bed in contact with an ophiolite, and has a somewhat variable aspect; in some portions it has a sub-conchoidal fracture with traces of crystallization; lustre shining, somewhat silky, color yellowish-white, sub-translucent. This variety, which is apparently homogeneous and exceedingly tough, has a hardness of 7·0, and scratches deeply the surface of agate; its specific gravity was found to be 3·333—3·364. It also occurs as a greenish-white or grayish-white somewhat granular rock, cavities in which are lined with small indistinct crystals; the density of this variety was 3·397—3·436.

Other specimens from the same locality exhibit the garnet intermingled with large cleavable masses of dark-green hornblende, which passes into a pearl-grey or lavender-grey variety. Small fragments of the garnet from this mixture had a density of 3·496; they were white, opaque, with a conchoidal fracture, and somewhat vitreous lustre. Intermingled with the garnet and hornblende, was another white or yellowish-white amorphous mineral, with a waxy lustre and a hardness of 6·0; the density

of a nearly pure specimen of it was 2·729, of another fragment 2·823. This, conjoined with its hardness, renders it probable that it is a feldspar; but it is very difficult to separate it from the garnet, or even to distinguish between the two species by the eye alone. Another specimen of a white granular rock from the same locality, which had been taken for garnet, had a density of only 2·800, and was supposed to be chiefly feldspathic in its nature. The specific gravity of the greyish hornblende was 3·046.

A specimen of the first described variety, having a density of 3·333 was selected for analysis; its powder did not effervesce with heated nitric acid, which however dissolved from it considerable alumina and lime. By the ignition of the rock, its yellowish color was only changed by the appearance of rare points of blackish-green. The analysis gave as follows:—

		Oxygen.
Silica,	44·85	23·69
Alumina,	10·76	5·03
Peroxyd of iron,	3·20	·96
Lime,	34·38	9·77
Magnesia,	5·24	2·09
Loss by ignition,	1·10	
	99·53	

If we suppose the alumina the peroxyd of iron and a portion of lime to form a garnet in which the oxygen ratios of the protoxyds, sesquioxyds and silica are 1 : 1 : 2, the residual lime and silica with the magnesia will be in the proportions requisite to form a pyroxene. We have lime 21·07, alumina 10·76, peroxyd of iron, 3·20, silica 22·69=57·72, with the oxygen content 5·99 : 5·99 : 11·98. There remains then for the pyroxene, lime 13·31, magnesia 5·24, silica 22·16=40·71, containing oxygen 5·87 and 11·71=1 : 2. The observed density of the rock corresponds very closely with that calculated for a mixture of lime-alumina garnet and pyroxene in the above proportions.—(*Geol. Survey of Canada*, Report, 1856, p. 449).

5. The great density of the above described garnet rocks and their association with hornblende, serpentine and feldspar, led me to suppose that similar rocks might have furnished to different chemists some of the discordant facts which are met with in the history of euphotide and saussurite. I have recently, however, through the kindness of Prof. Arnold Guyot, now of Princeton, New Jersey, had an opportunity of examining a collection of the euphotides of Switzerland, made by him in the course of his researches on the distribution of the erratic rocks of the basin of the Rhone. Prof. Guyot then traced the euphotides, which are found in scattered blocks and pebbles for a distance of nearly one hundred and fifty miles, to the valley of Sass, or rather to the corresponding chain of the Sassgrat, which forms a part of

Mt. Rose.* The euphotides of the Alps according to other observers are associated with protogine, ophiolites and crystalline schists.

I had now before me the original euphotides which had been studied by Haüy and de Saussure, and through the liberality of Prof. Guyot was furnished with numerous specimens of the characteristic varieties. Their examination has afforded me the following mineral species: saussurite, smaragdite, actinolite, talc, feldspar, and rarely pyrites.

The saussurite, which is generally predominant, is very uniform in its characters; it is always finely granular or compact, very tough, and with a sub-conchoidal or splintery fracture. Its color is white, passing into greenish bluish and yellowish-white, rarely with flesh-red stains; sub-translucent; lustre feeble, waxy. Hardness 7·0; scratches quartz. Specific gravity 3·33—3·38. A euphotide containing cleavable masses of smaragdite an inch in diameter, afforded me portions of bluish-white saussurite, apparently homogeneous, and having a density of 3·336—3·365. Another specimen of euphotide, containing a good deal of talc, and only small grains of smaragdite, had a density in the mass of 3·315, but selected fragments of the saussurite gave the number 3·385. Another large fragment of greenish-white saussurite had a specific gravity of 3·338, while a fourth specimen of euphotide holding only small lamellæ of smaragdite, and mingled with greenish-gray talc, had a distinctly granular texture, and a density of only 3·16—3·20.

The smaragdite of all these varieties of euphotide has a grass green color passing into emerald and olive-green. Lustre somewhat pearly; hardness 5·5; specific gravity of fragments from the first-mentioned euphotide, 3·10—3·12. The smaragdite generally exhibits only the cleavages of pyroxene, but in some cases it is irregularly penetrated by slender prisms of hornblende.

Talc is rarely absent from these euphotides, and is often abundant in small foliated or radiated masses, enclosed in the saussurite. The talc is generally silver-white, but occasionally appears greenish from the presence of minute crystals of dark green actinolite, which may be seen penetrating the talc, in close proximity to the yellowish-green smaragdite. The latter I have always found enclosed in the saussurite.

A bluish-gray or lilac feldspar is often met with in these euphotides, and is at once distinguished from the saussurite by its color, cleavage, translucency, vitreous lustre, and inferior hardness. I have not observed cleavage faces of this feldspar more than a fourth of an inch in length, although in some specimens it is rather abundant. Grains of it are sometimes imbedded in the talc, but it more generally occurs in the saussurite.

* See also Jas. Forbes, *Travels through the Alps*, p. 352.

This feldspar is completely decomposed by heated sulphuric acid, and contains a large proportion of lime, characters which show it to be labradorite or an allied variety.

Two specimens of saussurite were selected for analysis, the bluish-white variety from the first mentioned euphotide having a specific gravity of 3·365, (VI) and selected fragments of a greenish-white variety from the second, with a density of 3·385, (VII). This was penetrated by talc, from which it was impossible, completely to separate it. The eleutriated mineral was decomposed by prolonged fusion with carbonate of soda, the separated silica and alumina being in each case carefully analyzed. The alkalies were determined by J. Lawrence Smith's method of igniting with carbonate of lime and sal-ammoniac, and consisted of soda with but traces of potash. The results were as follows:

	VI.	Oxygen.	VII.	Oxygen.
Silica,	43·59	23·25	48·10	25·65
Alumina,	27·72	13·95	25·34	11·94
Peroxyd of iron,	2·61	·78	3·30	·99
Lime,	19·71	5·63	12·60	3·60
Magnesia,	2·98	1·19	6·76	2·70
Soda,	3·08	·80	3·55	·91
Loss by ignition,	·35	....	·66	....
	100·04		100·31	

Boiling concentrated sulphuric acid removed only traces of alumina and lime from the pulverized saussurite, which was however partially decomposed by this acid after having been strongly ignited.

The hardness and specific gravity of saussurite assign it a place with epidote. Rammelsberg has recently published the analyses of six varieties of lime-alumina epidote or zoisite, varying in density from 3·25 to 3·36, and finds the oxygen ratios of the protoxyds, peroxyds and silica to be nearly as 1 : 2 : 3, often however with an excess of silica. The ratios of his analyses vary between the limits 1 : 1·94—2·16 : 2·95—3·36.—(*Berlin Acad. Ber.* 1856, 605).

If we follow Rammelsberg, who has regarded the small amount of iron in the zoisites, as peroxyd replacing alumina, we have for the analysis VI the ratios 7·62 : 14·73 : 23·25=1 : 1·93 : 3·05, while for VII we have 7·21 : 12·93 : 25·65, showing an excess both of silica and protoxyd, due to the intermingled talc. If we regard this surplus of protoxyd as magnesia it would equal 5·70 per cent of talc, and deducting the elements of this from the analysis, we have for the oxygen ratios of the saussurite the numbers 1 : 2 : 3·29. Saussurite has then the hardness, specific gravity and chemical composition of a lime-alumina epidote or zoisite, containing small portions of magnesia and soda, which are frequently present in this species. The analyses of

various epidotes give from two to six per cent of magnesia, and from one to more than two per cent of soda.*—(See *Dana's Mineralogy*, 4th Ed., ii, 407).

6. The composition of zoisite as already noticed by Rammelsberg is identical with that of meionite, a species which is shown by its hardness of 6·0 and its density of 2·6—2·7, to belong to the dimetric division of the feldspar group, where it is to the scapolites what anorthite (with the ratios 1 : 3 : 4,) is to the triclinic feldspars. The mineral described by Boulanger as saussurite from Mt. Genèvre, with a density of 2·65, gives according to his analysis (III) the oxygen ratios 7·37 : 14·18 : 23·75=1 : 1·91 : 2·22, and appears to have been meionite. In de Saussure's analysis, (II) if we regard the iron as protoxyd, we obtain the ratios 5·22 : 14·02 : 23·50, but there is then a deficiency of 4·50 p. c. in the analysis of an anhydrous mineral. Klaproth's results (I) seem to indicate a mixture of a silicate like pyroxene or talc as in VII, while the anomalous softness of V and the facility with which it is decomposed by acids, render it difficult to form any conclusion about the saussurite of the Fiumalto examined by Boulanger. His analysis of the saussurite of Orezza (IV) gives the oxygen ratios 7·23 : 14·95 : 23·25=1 : 2·06 : 3·21, so that it has the composition of meionite and zoisite, while its specific gravity is between the two. Although inferior in hardness, it resembles zoisite in resisting according to Boulanger the action of concentrated sulphuric acid.

The saussurite of Orezza evidently demands farther study; it remains to be seen whether the *verde di Corsica* or *verde antico di Orezza*, as it is also named, (the corsilite of Pinkerton, *Petralogy*, ii, 78), which is regarded by d'Halloy as the typical euphotide, is not distinct from that of Mt. Rose. Delesse found the specific gravity of the Corsican euphotide to be only 3·10. The name

* Laurent in an essay on the silicates published in 1849, insisted that distinctions based on the relations between the proportions of protoxyds and sesquioxyds are of but secondary importance, since these oxyds may replace each other to an indefinite extent in many silicates, without altering the mineral type. This principle Laurent then illustrated by the epidotes among other species, showing from Hermann's analyses of thirteen specimens (of which the analyst had made three sub species,) that although the oxygen ratios of the protoxyds and sesquioxyds offered considerable variations, it was possible by admitting the substitution of the one for the other, to reduce all these epidotes to the same formula with garnet, SiO_2R_2, *i. e.*, SiO+RO, in which RO, represents both protoxyds like CaO, and sesquioxyds like alO (=$Al_2O_3 \div 3$).—(*Comptes Rendus der Travaux de Chemie*, 1849, p. 277).

This idea of Laurent although at the time rejected, is now universally admitted Dana has adopted it in the 4th Ed. of his Mineralogy; Hermann has recently reviewed his own analyses and accepts Laurent's view, while Rammelsberg who illustrated it in his laborious researches on the tourmalines, has recently applied it to the augites and hornblendes containing peroxyd of iron. But while there is no doubt of the general and wide application of this principle of the homœmorphism of protoxyds with sesquioxyds, it is nevertheless true as Dana has remarked, that in the epidotes the variations in the oxygen ratios of the protoxyds, sesquioxyds and silica are about 1 : 2 : 3, which may be looked upon as the normal ratio for epidote, as 1 : 1 : 2 is for garnet, and 3 : 2 : 5, for idocrase.—(This Jour., [2,] xxv, 406).

of *verde di Corsica*, which in the arts is applied to the rock as a whole, is by Beudant restricted to the contained smaragdite.

I have lately examined a pale yellowish-green compact and apparently homogeneous rock, which forms great beds among the crystalline schists of the Shickshock mountains in Gaspé, and has somewhat the aspect of saussurite. Its hardness is 7·0 and its density 3·04—3·09. It is exceedingly tough and sonorous, has a conchoidal fracture with a feeble waxy lustre, and is translucent on the edges. The analysis gave as follows:

		Oxygen.
Silica	62·60	33·38
Alumina	12·30	5·78
Protoxyd of iron	9·40	2·82
Lime	14·10	4·03
Magnesia	·72	·29
Soda with a trace of potash	·43	·11
Loss on ignition	·16	
	99·71	

The oxygen of the protoxyds and peroxyds in the above analysis equals 4·43 and 8·60. If to these we add the silica corresponding to 13·00 of oxygen, we shall have 61·33 parts of epidote, leaving 32·22 parts of silica uncombined. The density of the mass is that of a mixture of epidote and quartz in the above proportions, and in some specimens where the rock becomes granular, the two species are easily distinguishable. (*Geol. Survey of Canada, Report*, 1858). This epidote rock then is completely distinct from the saussurite of Orezza.

The two silicates zoisite and meionite offer a remarkable instance of that isomerism in mineral species upon whose importance I have long insisted. The relation of the specific gravity to the empirical equivalent weights of minerals, must enter as an essential element into a classification which shall unite the chemical and natural-historical systems. Similar isomeric relations exist between kyanite and sillimanite, rutile and anatase, and as I have elsewhere endeavored to show, among the carbon-spars. It becomes necessary in the study of mineral species to determine their relative equivalent weights, to which specific gravity must be the chief guide.—(*Proc. Am. Assoc. Adv. Science*, 1854, pp. 240–247).*

* The action of heat upon organic bodies of high equivalent tends to resolve them into simpler and less dense forms, (we except of course the simultaneous productions of small portions of more complex hydrocarbons). Similar results are obtained when the denser silicates are fused. Thus according to Magnus the specific gravity of garnet is lessened one-fifth by fusion, while that of idocrase is reduced from 3·34 to 2·94. Epidote by ignition has its density changed from 3·40 to 3·20 according to Rammelsberg, and saussurite is converted by fusion into a soft glass of specific gravity 2·8. The silicates thus modified are decomposable by acids like the basic feldspars; idocrase and garnet crystallize after fusion, the latter according to von Kobell in octahedrons. Deville found the density of hornblende and pyroxene to be reduced by fusion from 3·2 to 2·8, orthoclase from 2·56 to 2·35, and labradorite from 2·689 to 2·525.

7. *Smaragdite.*—The smaragdite or diallage of the euphotides appears to have been first examined by Vauquelin, who found in a specimen from Corsica with specific gravity 3·0; silica 50·0, alumina 21·0, lime 13·0, magnesia 6·0, oxyd of iron 5·5, oxyd of chromium 7·5, oxyd of copper 1·5=104·5. (Beudant, *Mineralogie*, ii, p. 134). Boulanger subsequently analyzed the diallage from the euphotide of the Fiumalto already described. It had a density of 3·10, and gave silica 40·8, alumina 12·6, lime 23·0, magnesia 11·2, protoxyd of iron 3·2, protoxyd of manganese 1·4, oxyd of chromium 2·0, water 5·2=99·4.—(*Ann. des Mines*, [3], viii, 159).

I have analyzed the grass-green smaragdite already described as occurring in masses an inch in diameter imbedded in the saussurite VI. It was to some extent penetrated by the latter mineral, and contained irregularly disseminated slender prisms of hornblende, apparently associated with talc. The analysis gave as follows:

Silica,	54·30
Alumina,	4·54
Lime,	13·72
Magnesia,	19·01
Protoxyd of iron,	3·87
Oxyd of chromium,	·61
Oxyd of nickel,	*traces*
Soda,	2·80
Loss by ignition,	·30
	99·15

A partial analysis of another specimen gave alumina 3·80, lime 14·22, magnesia 18·07, protoxyd of iron 2·34. The pale green color of the powdered smaragdite becomes brownish on ignition. The small portion of nickel, whose presence I have already shown in a great number of chromiferous serpentines and diallages,* gave evidence of a trace of cobalt before the blowpipe. The oxygen ratios of the silica, alumina and protoxyds in the above analysis are as 28·96 : 2·12 : 13·29. Its composition is evidently that of a pyroxene, with some admixture of saussurite and probably of talc. A portion of the latter mineral from one of the euphotides of Mt. Rose, was submitted to analysis, and allowing for a small admixture of saussurite, was found to have the composition of ordinary talc, being a hydrated silicate of magnesia with a little iron and a trace of nickel.

Conclusions.—1. The true euphotide is distinct from the diallagic dolerites, with which most modern lithologists have confounded it, and which are composed of pyroxene and a feldspar having the constitution of andesine, labradorite, or a still more basic variety approaching to anorthite. By the substitution of hornblende for pyroxene these dolerites pass into diorite or diabase.

* This Journal, [2,] xxvi, 237.

2. The euphotides of Mt. Rose according to my observations are composed of smaragdite (a pyroxene containing chrome and nickel,) in a base of saussurite, which is a compact zoisite, or lime-alumina epidote, containing portions of magnesia and soda, and having a hardness of 7·0 and a specific gravity of 3·33—3·38; characters which at once distinguish it from the feldspars. These euphotides also contain as accidental minerals, talc, actinolite and occasionally a vitreous cleavable feldspar resembling labradorite.

3. While the minerals analyzed as saussurite by Stromeyer and Delesse are feldspars, that from Mt. Genèvre examined by Boulanger has the composition and specific gravity of meionite, a species which is isomeric with zoisite; the saussurite from Orezza according to the same observer has a like composition but a density intermediate between these species. The saussurite examined by Thompson is apparently a petrosilex.

4. By its great density and its composition, the euphotide of Mt. Rose is related to certain rocks in which a white garnet, resembling saussurite, is mixed with serpentine, with hornblende, and with a feldspathic mineral. These aggregates associated with ophiolites, albitic diorites, and a rock made up of epidote and quartz, occur in the form of beds in the crystalline schists of the altered Silurian series in Canada.*

ART. XXXVIII.—*The Dynamic Theory of the Tides;* by Maj. J. G. BARNARD, A.M., Corps of Engineers, U. S. A.

IN his treatise on "Tides and Waves," Mr. Airy uses in reference to Laplace's investigation of the tides, the following language:

"If now, putting from our thoughts the details of the investigation, we consider its general plan and objects, we must allow it to be one of the most splendid works of the greatest mathematician of the past age. To appreciate this, the reader must consider, first, the boldness of the writer who, having a clear understanding of the gross imperfection of the methods of his predecessors, had also the courage deliberately to take up the problem on grounds fundamentally correct, (however it might be limited by suppositions afterwards introduced); secondly, the general difficulty of treating the motions of fluids; thirdly, the peculiar difficulty of treating the motions when the fluids cover an area which is not plane but convex; and, fourthly, the sagacity of perceiving that it was necessary to consider the earth as a revolving body, and the skill of correctly introducing this consideration. The last point alone, in our opinion, gives a greater claim for reputation, than the boasted explanation of the long inequality of Jupiter and Saturn."

* See my *Contributions to the History of Ophiolites*, this Journal, [2], vol. xxv, 217, and xxvi, 234.

The equilibrium-theory, manifestly false in treating the problem simply as one of statics, disregarding the *motions* of the fluid which must accompany the changes of its superficial form, is, at least, an *explanation* of the phenomenon, though not a true theory.

Mr. Airy remarks of it;

* * * * "it must be allowed that it is one of the most contemptible theories that was ever applied to explain a collection of important physical facts. It is entirely false in its principles, and entirely inapplicable in its results. Yet, strange as it may appear, this theory has been of very great use. It has served to show that there are forces in nature following laws which bear a not very distant relation to some of the most conspicuous phenomena of the tides; and, what is far more important, it has given an algebraic form to its own results, divided into separate parts analagous to the parts into which the tidal phenomena may be divided, admitting easily of calculation and of alteration, and thus at once suggesting the mode of separating the tidal movements, and affording numerical results of theory with which they are to be compared. The greatest mathematicians and the most laborious observers of the present age have agreed equally in rejecting the *foundation* of this theory, and comparing all their observations with its *results*. And till theories are perfect (a thing scarcely to be hoped for in any subject, and less in the tides than any other,) this is one of the most important uses of theory."

If we could indeed *grasp* the conditions of the problem—bring into our analysis the expression of the *actual form* (or even a tolerable approximation to that form) of the solid nucleus whose depressions form the ocean beds, then indeed the solution would be that which we seek, not a mere *explanation*, but a true expression for the phenomena, as they actually occur.

While we are utterly incapable of doing this—when such a mind as Laplace's is found unable to grasp the conditions of a "Dynamic Theory," it seems to me that Mr. Airy wastes epithets upon the "equilibrium theory" which, after all, I presume no physicist ever regarded as a *real theory* of the tides, but rather a mere putting into mathematical form of their obvious *immediate* cause. If, to get over the difficulties of the *true theory*, and bring the problem within the grasp of our mathematics, we are obliged to make assumptions, entirely at variance with the facts which really govern the question—which cannot even *approximate* to them—we might as well, so far as the *solution* we seek is concerned, go one step further, and suppose there is no motion at all—or that the fluid is destitute of inertia; in other words fall back upon the equilibrium theory, for the problem is no longer that which we propose, but a mere mathematical study which may yield us some curious results.

"It was found necessary, however, (Airy 'Tides and Waves,") in order to make the application of mathematics practicable, to start with two suppositions, which are inapplicable to the state of the earth. These are: that the earth is covered with water; and that the depth of this water is the same through the whole extent of any parallel of latitude."

If the *actual configuration* of the ocean's bed is, as I have before remarked, the very basis of a dynamic theory of the tides, then a theory which is obliged to reject entirely this actual configuration, and instead of ocean beds of *limited* areas, isolated from each other by dry land in those parallels where the tidal effects are greatest, substitute an imaginary ocean covering the *whole globe*, and of the *same* depth following each parallel of latitude, the problem can be only a mathematical one of more or less interest, from which nothing of any practical value, as to the *actual* phenomena of the tides, can be expected.

Such *is*, in fact, the dynamic theory of Laplace; it has furnished no result nor been of the slightest use to physicists in their investigations of the tidal phenomena. Mr. Airy remarks, "under these suppositions (the arbitrary assumptions as to the ocean's extent and depth) it is evident that the theory is far from being one of practical application;" but when we consider that, in the very effort to make the theory a dynamic one, by introducing the motions of the fluid particles, the *real motions* as governed by the actual configuration of the ocean beds are discarded and purely imaginary ones substituted, we may well hesitate in giving assent to the proposition which finishes the sentence; "though it clearly approaches much nearer to truth than the theory of equilibrium which we have already described."

In the eye of the mere *theorist* it may be so, but to one who seeks a knowledge of the tides as *they actually are*, the equilibrium theory is far more useful; and of two things neither of which possess any claims to be called true, one may be considered as true or the other.

The differential equations which determine the elevation and motion of the water, when the question is limited by these arbitrary assumptions already mentioned, are obtained with no great difficulty. In fact, the equilibrium theory gives the elevation of the water as *it would be* were the water destitute of inertia; in other words, the forces of attraction of the earth and of the disturbing bodies are alone considered, while the forces of inertia in the water itself are disregarded. We have only to introduce *these* forces to convert the equilibrium into a dynamic theory; and thus considering the effects of the fluid motions only in the forces of inertia developed, it follows from the general equations of equilibrium of fluids, that the total fluid pressure resulting will be the sum of the pressures due to the separate existence of each class of forces.

Calling p the total fluid pressure at any point, arising from the action of all the forces, p' the pressure due to the earth's attraction, were its surface undisturbed, p'' the pressure due to the attractions of the disturbing body, p''' the pressure due to the forces of inertia in the fluid, we shall have

$$p = p' + p'' + p'''.$$

If we desire to have the value of p at the *undisturbed surface of the* earth, put $p'=0$ and we have $p=p''+p'''$.

If we call w the height of the fluid column due to the pressure p, and q the height due to p'', we shall have (considering the density as unity) $p=gw$, $p''=gq$, and

$$(1) \qquad gw = gq + p''',$$

in which w is the *total tidal elevation* due to the disturbing attractions, and to the inertia of the fluid, and q is the elevation due to the disturbing attractions alone; in other words, it is the height *due to the equilibrium theory.*

Confining the investigation, for simplicity, to the attractions of the *sun* alone, we shall find from the equilibrium theory (vide Airy's "Tides and Waves" par. 44,)

$$(2) \quad q = S'\left(\frac{P}{P_m}\right)^3\Big[(\tfrac{3}{2}\cos^2\sigma - 1)(1-3\sin^2\lambda) + \tfrac{3}{2}\sin 2\lambda \sin 2\sigma \cos(l-s) + \\ + \tfrac{3}{2}\cos^2\lambda \cos^2\sigma \cos 2(l-s).$$

In which S and σ are the celestial right ascension and declination of the sun; λ and l the terrestrial latitude and longitude of the place, (the latter referred to a meridian *fixed in space*); P the actual and P_m the mean parallax of the sun and S' a coefficient which (vide par. 41 and 42) $= \dfrac{Sb^2}{2gD^3}\left(\dfrac{P_m}{P}\right)^3$ (the density of the water being considered insignificant compared to that of the earth) in which S and D are the sun's mass and distance, b the earth's polar radius,* and g the force of terrestrial gravity.

In the equation (2) the angle $(l-s)$ is the difference in *longitude* of the point of observation and the sun, referrred to a meridian *fixed in space.* If we consider the earth a revolving body and call ϖ the longitude of the point, referred to a meridian on the earth's surface, and n the velocity of rotation, then the variable longitude of the point of observation, at the end of the time t, referred to a meridian fixed in space, will be represented by $nt+\varpi$, and the angle $l-s$, by $nt+\varpi-s$.

If instead of the latitude λ we use the *polar distance* θ of the point of observation we shall have

$$\cos\lambda = \sin\theta, \text{ and } \sin 2\lambda = \sin 2\theta.$$

* The *spheroidal* form is disregarded, as the tidal *displacements* are very nearly the same whether the earth is regarded as a sphere or spheroid.

Making the substitutions in equation (2), and then substituting the value of gq in equation (1), we have

$$(3)\quad gw=\frac{Sb^2}{2D^3}\left(\tfrac{3}{2}\cos^3\sigma-1\right)(1-3\cos^2\theta)+\frac{3Sb^2}{4D^3}\sin 2\sigma\,.\sin 2\theta\cos(nt+\varpi-s)\,.$$
$$+\frac{3Sb^2}{4D^3}\cos^2\sigma\,.\sin^2\theta\,.\cos 2\,(nt+\varpi-s)+p'''.$$

If, now, we suppose a particle of water running towards the south and call u the arc (in latitude) passed over at the end of the time t, $b\frac{du}{dt}$ will be the *actual velocity* of the particle, in this direction, and $b\frac{d^2u}{dt^2}$ its acceleration. If θ is the angular polar distance of the initial position of the particle, $b\theta$ will be the actual lineal polar distance, and $\frac{dp'''}{bd\theta}$ will be the differential coefficient of the pressure arising from a variation of θ, and by a slight and admissible extension of the fundamental equations of hydrodynamics we should have $\frac{dp'''}{bd\theta}=-b\frac{d^2u}{dt^2}$.

But if the particle has, at the same time, a component of velocity towards the east, represented by $b\sin\theta\frac{dv}{dt}$ (v being arc in longitude moved over in the time t,) its centrifugal force is increased from $\frac{n^2b^2\sin^2\theta}{b\sin\theta}$ (due to the earth's rotation *alone*,) to $\frac{\left(n+\frac{dv}{dt}\right)^2b^2\sin^2\theta}{b\sin\theta}$, the difference between which is (omitting the term containing the square of $\frac{dv}{dt}$ since it is very small compared to n) $2nb\sin\theta\frac{dv}{dt}$, and the component of this increment, $2nb\sin\theta\cos\theta\frac{dv}{dt}$, will press the particle *towards* the equator and is to be added to the value of $\frac{dp'''}{bd\theta}$ before obtained. Adding it and multiplying by b, we have

$$(4)\quad \frac{dp'''}{d\theta}=-b^2\frac{d^2u}{dt^2}+2nb^2\sin\theta\cos\theta\frac{dv}{dt}.$$

Considering now the component of angular velocity to the east $\frac{dv}{dt}$, since the radius of the small circle of latitude in which it

moves is $b \sin \theta$, the actual lineal component of velocity would be $b \sin \theta \frac{dv}{dt}$, while the differential coefficient of the pressure (in space) will be $\frac{dp'''}{b \sin \theta d\varpi}$, and considering this motion *alone*, we should have $\frac{dp'''}{b \sin \theta d\varpi} = - b \sin \theta \frac{d^2 v}{dt^2}$.

But the particle of water has at the same time a southerly component of velocity $b \frac{du}{dt}$.

It is evident that, as it is passing to a lower and larger circle of latitude, to maintain its position in longitude, the moment of its quantity of motion, with reference to the axis of the earth's rotation, will be increased.

The principle that the moment of the accelerating force is equal to $\frac{d}{dt}$ (the moment of the quantity of motion) (which can be easily deduced from the equations of rotation around a fixed axis—see Bartlett Analyt. Mechanics, par. 229,) will enable us to determine the value of $\frac{dp'''}{d\varpi}$ corresponding to this cause. The accelerating force in this case (or the pressure generated by this motion of the particle) is $\frac{dp'''}{b \sin \theta d\varpi}$, and its moment with reference to the earth's axis is $\frac{dp'''}{d\varpi}$.

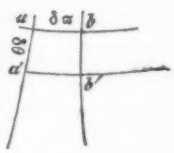
The moment of the quantity of motion of the particle of water (per unit of mass) due to the earth's rotation, is $nb^2 \sin^2 \theta$, of which the $\frac{d}{dt}$ is $2nb^2 \sin \theta \cos \theta \frac{d\theta}{dt}$. But as the change in the polar distance of the particle is due to the component of velocity $\frac{du}{dt}$, $\frac{d\theta}{dt}$ will be expressed by the same, and hence, from this cause we should have $\frac{dp'''}{d\varpi} = - 2nb^2 \sin \theta \cos \theta \frac{du}{dt}$. (The negative sign is used since the increment of the pressure is in the reverse direction to that of ϖ).

Adding this value to that previously obtained, we have

$$\frac{dp'''}{d\varpi} = -2nb^2 \sin \theta \cos \theta \frac{du}{dt} - b^2 \sin^2 \theta \frac{d^2 v}{dt^2}. \tag{5}$$

Another equation may be obtained from the condition of *continuity* in the fluid.

Let $aa'\,b'b$ be an elementary area of ocean surface, the angular co-ordinates of a being ϖ and θ, and ab and aa', being equal to $\delta\varpi$ and $\delta\theta$. Let the *depth* of the water at a be γ. According to the assumption with regard to the depth alluded to before, γ varies with the polar distance θ, but not with the longitude ϖ.



Let us suppose the water flowing over this area with angular components $\frac{du}{dt}$ southward and $\frac{dv}{dt}$ eastward; velocities which are themselves variable with θ and ϖ and the time. Taking a space of time t, from the origin of motion, the water will flow past the point a with a velocity which would carry it in that time through the space u, and past the point a', through the space $u+\frac{du}{d\theta}\delta\theta$.

The area of the section ab is $\gamma\delta\varpi$, and of the section $a'b'$, is $(\gamma+\frac{d\gamma}{d\theta}\delta\theta)(1+\cot\theta\delta\theta)\delta\varpi$. (Since it is easily seen that the side $a'b'$ is to ab (or $\delta\varpi$) as $\sin(\theta+\delta\theta):\sin\theta$; or as $1+\cot\theta\delta\theta:1$ (nearly). Therefore the quantity of water which flows through the section ab in the short time t, will be $u\gamma\delta\varpi$, and through the section $a'b'$ will be $(u+\frac{du}{d\theta}\delta\theta)(\gamma+\frac{d\gamma}{d\theta}\delta\theta)(1+\cot\theta\delta\theta)\delta\varpi$. The *difference* between these quantities, is the quantity of water subtracted from (or added to) the ocean area $aa'\,b'b$, and is (omitting quantities of the 3d order)

$$\frac{d}{d\theta}(u\gamma)\delta\theta\delta\varpi+u\gamma\cot\theta\delta\theta\delta\varpi.$$

The *area* of the section $aa'\,b'\,b$ is (nearly) $\delta\theta\delta\varpi$ (for convenience, the multiplication by the radius of the earth is omitted with all these angular quantities, as it does not affect the results) and the fall (or rise) of the tide w, due to the southern component of tidal motion, will evidently be equal to the foregoing expression divided by the area $\delta\theta\delta\varpi$.

If we now consider the eastern component of velocity $\frac{dv}{dt}$, the quantity of water which runs eastwardly through the section aa' whose area is $\gamma\delta\theta$ in the time t is $\gamma v\delta\theta$, and the quantity which flows through $b\,b'$ (since both γ and $\delta\theta$ are constant in this direction) $\gamma(v+\frac{dv}{d\varpi}\delta\varpi)\delta\theta$, and the difference $\gamma\frac{dv}{d\varpi}\delta\theta\delta\varpi$, is the quantity of water subtracted from the area $aa'b'b$ through the eastern component of tidal velocity.—Adding this to the foregoing expression, and dividing by $\delta\theta\delta\varpi$ we get the actual total fall (or rise) of the tide,

$$w = -\frac{d}{d\theta}(u\gamma) - u\gamma \cot\theta - \gamma \frac{dv}{d\theta} \qquad (6)$$

(The negative sign is used since w represents the elevation, positive or negative, above the undisturbed surface, and if u, and v increase with θ and ϖ, in the preceding discussion, there will be a *fall* of tide.)

Referring back now to equation (3), Mr. Airy has shown (par. 85, 86, "Tides and Waves") that each term multiplied by S may be put under the general form

$$\Theta \cos(it + k\varpi)$$

in which Θ is a function of θ alone: and also that "the equation between w, u, and v; those between p''', u and v; and that between w, p''', and the terms arising from the disturbing force, being all linear, we may take the terms arising from the disturbing force separately, and, finding the solution for each term, we may add all together. It will be sufficient, therefore, to proceed with the solution of the equation" (instead of equation (3))

$$0 = \Theta \cos(it + k\varpi) - gw + p'''$$

and combining this with equations (4), (5) and (6),

$$\frac{dp}{d\theta} = -b^2 \frac{d^2u}{dt^2} + 2n b^2 \sin\theta \cos\theta \frac{dv}{dt}$$

$$\frac{dp'''}{d\varpi} = -2n b^2 \sin\theta \cos\theta \frac{du}{dt} - b^2 \sin^2\theta \frac{d^2v}{dt^2}$$

$$w = -\frac{d}{d\theta}(u\gamma) - u\gamma \cot\theta - \gamma \frac{dv}{d\varpi},$$

we have Laplace's differential equations of tidal motions (as given by Mr. Airy).

"A general solution of these equations is scarcely to be hoped for; it is a matter of difficulty to find, in a very limited case, a particular integral which will satisfy them."—(Airy, *Tides and Waves.*") And the particular integral essayed by Laplace and Mr. Airy is of the following form:

$$w = a \cos(it + k\varpi)$$
$$u = b \cos(it + k\varpi)$$
$$v = c \sin(it + k\varpi)$$
$$p''' = a''' \cos(it + k\varpi)$$

in which a, b, c, a''' are functions of θ only.

It is not my purpose to follow the investigation any further, which is purely analytical and consists in determining for each term of equation (3), the values of these quantities, and, thence, of w, u, v, p''', by which we get the elevation, velocity, direction of motion, &c. of the tides arising from the disturbing forces expressed by the particular term.

I will only remark that the compulsory resort to this particular integral *fixes* the original assumption of an ocean covering the whole surface of the globe, irrevocably,—these values of w, u, v, and p''', being simple perturbating functions, whose perturbations in time correspond exactly with those of the forces, while they extend *in space* through the *whole* circumference of the earth, without the possibility of limitation in that direction. In short, it is the particular integral which expresses that *particular tide* belonging to an ocean *continuous in longitude.*

Excepting the arbitrary restriction applied to the variation in *depth*, the differential equations (3), (4), (5) and (6), are perfectly general, and could a general integral be obtained, a limitation of the ocean's area (approximating feebly to the continental barriers) could be established—and, thence, results which might be considered approximations to the actual phenomena. Such an integral, however, is not likely to be obtained, neither Laplace nor Mr. Airy having cared to attempt it.

"As it is, Laplace's theory fails totally in application, from the impossibility of introducing in it the consideration of the boundaries of the sea."

* * * * * * *

"If we look to the results of the theory, it will be found that they are rather of a negative than of a positive kind. They show that, without a far more complete knowledge of the form of the bottom of the sea than we can hope to possess, it will be impossible, even with more powerful mathematics, to calculate tides *à priori*. They show that the calculations founded on the equilibrium-theory cannot be good for anything. In proving that (with sea at least of a certain shallowness) the part of the equator next to the moon would be a place of *low* water, they destroy all hope of using an equilibrium-theory, even as an approximation. In establishing the remarkable result as to the non-existence of diurnal tide in height when the depth is uniform, they show that no inference can be drawn from the mere magnitude of a force as to the magnitude of its effects."—(*Airy*, "*Tides and Waves.*")

It does not seem to me that so difficult and profound a course of analysis was at all necessary to arrive at everything in these negative results at all important.

The remark in the beginning of this paper that "the *actual shape* of the ocean's bottom is the very foundation of a dynamic theory of the tides," seems almost self-evident. But our *mathematics*, thus far, has failed to grasp even the simplest approximation to *shore-outline*,—and if we had the most perfect knowledge of the form of the bottom of the sea, it would be far beyond the powers of analysis to introduce, with any accuracy, its consideration into the problem. Remarks of a similar nature might be made as to the conclusions concerning the equilibrium-theory, which, it seems to me, no philosopher could ever have regarded as *a solution*. Laplace having failed to show what the

effect of the continental barriers is, it cannot be considered as *proved*, that the equilibrium-theory is not as near an "approximation" as anything else we have or are likely to have.

My object in this paper has been to show by what simple considerations and processes the differential equations of Laplace's theory may be arrived at. In doing so I am perfectly well aware that the finding a short path to a *known result* is quite a different affair from the original discovery, and I must also remark that the *considerations* from which equations (4) and (5) are deduced are pointed out (after he has arrived at the equations by long and tedious processes) by Mr. Airy himself.

Mr. Airy concludes his able work on "Tides and Waves," by a "Theory of Waves in Canals," and which, as embracing the subject of the tides, applies to cases such as rivers and arms of the sea, to which neither the equilibrium nor dynamic theory would (if applicable elsewhere) apply,—and to "cases of open seas, where the whole may be conceived divided into parallel canals in which the circumstances are nearly similar."

The "theory" is a very beautiful one and a very valuable contribution to physical science; more valuable, I think however, for its thorough discussion of *waves* in all (or nearly all) the aspects in which they present themselves to the navigator, naval constructor, or engineer, than for its application to the tides. Though it doubtless comes much nearer an approximation to the circumstances under which the tides actually flow in rivers or arms of the sea, than the dynamic or equilibrium theories do to the tides of the ocean, yet the vast difference between the *actual* configuration of shores and beds of such canals, and the simple assumptions the theory is confined to, will probably render this, like all other theories, useless, or nearly so, in practice.

The subject of the tides of the ocean, though perhaps as intelligible as a physical phenomenon, as most others in astronomy, is in its *actual manifestations*, entirely beyond the grasp of our mathematics,—beyond any reasonable conception we can form as to the powers of the human mind to grasp, through any supposed improvement in the means of mathematical analysis. It is probable that, for the aid of the investigator, the "equilibrium theory" has done as much as any theory can be expected to do.

Art. XXXIX.—*On some Fossil Plants of Recent Formations;* by Leo Lesquereux.

The fossil plants of our recent formations have until now attracted little attention. The difficulty of identifying species of dicotyledonous plants from fragments of leaves only, is perhaps the cause of this neglect. Nevertheless the plants of the tertiary and quaternary strata will likely give a solution to some important problems in natural history. Botanists are now intently looking at the flora of those formations, not only to satisfy their minds in regard to the distribution of species of plants in the different strata, but to trace to its farthest limits the history of our present vegetation. They wish to find the origin of some genera and species now living on our earth, to trace their geographical distribution by recording their appearance and destruction at certain places and at a precise time, collecting thus, if possible, some facts that may help to unravel the causes which have changed and may still modify the march of vegetation. It is besides well known and easily understood that plants are more easily influenced by atmospherical changes than animals, at least than testaceous animals, which are those most commonly preserved in the geological strata, these only showing the changes in the sea. Even as characteristic of alluvial or fresh water formations, plants are more reliable than the remains of terrestrial animals, exposed to accidental and unaccountable migrations. The leaf of a palm tree found in the quaternary strata of Northern Russia could never have excited such discussions as did the remains of the elephant found there imbedded in the ice. We may therefore expect to obtain from botanical palæontology more precise indications about the succession of certain geological strata than from shells and animal remains only. This expectation is confirmed by the flora of the different strata of the coal-measures which is evidently different, at least as regards some of the species of plants, for each bed of coal.

Among the collections of fossil plants that have lately come under my examination, the most interesting, by far, is the one made by Dr. John Evans in his U. S. Surveying expedition of Oregon territory, Vancouver Island, &c. A description of these fossil plants appears just now to be a valuable contribution to science, and with the approval of the Secretary of the Interior, I have been advised by Dr. Evans to publish my remarks on those plants in advance of the publication of his report which will contain a full description of the fossil leaves with correct figures.

It will be interesting to mention and compare at the same time some species of fossil plants found by Prof. Jas. M. Safford in

the Pliocene of Tennessee, and some others collected by Dr. D. Dale Owen and myself in the chalk banks or Pleistocene of the Mississippi.

Species of Fossil Plants collected by Dr. John Evans at Nanaimo (Vancouver Island) and at Bellingham bay, Washington Territory.

1. *Populus rhomboidea* (Lsqx.). Leaves rhomboidal, with the margins irregularly toothed above, and entire near the slightly decurrent base. Lateral primary nerves diverging at an acute angle like the secondary ones, and ascending to both corners of the rhomb of the leaf, all strongly marked with scarcely visible percurrent veinlets. It is much like *Populus repando-crenata* of Heer, differing only by the leaves somewhat broader and by the undulations and teeth a little deeper. The *Populus mutabilis* with its numerous varieties is a characteristic plant of the upper Molasse or Miocene of Europe, especially found in the upper strata of Oeningen. (Nanaimo).

2. *Salix Islandicus* (Lsqx.). Leaves large, lanceolate, pointed, serrulate, rounded at the base. Secondary nerves in acute angles with the medial nerve, nearly straight and numerous. Subdivisions of the nerves invisible. A willow with very large leaves, apparently identical with *Salix macrophylla* (Heer) of the Miocene of Europe. (Bellingham bay.)

3. *Quercus Benzoin* (Lsqx.). Leaves shining, oval, with undulate and entire margins decurrent on the petiole. Basilar secondary nerves opposite and emerging in an acute angle above the margin and ascending to the third of the length of the leaves. Upper secondary nerves more open and diverging. The kind of nervation of this leaf is peculiar to a few species of oaks, and has also some likeness to that of the genus Benzoin. This species is distantly related to *Quercus Charpentieri* (Heer), common in the Miocene of Switzerland. (Nanaimo.)

4. *Quercus multinervis* (Lsqx.). Leaves apparently shining and oval like the former; but differing much in the numerous, deeply marked, secondary nerves all parallel, emerging in an obtuse angle from the medial nerve, and slightly arched. It is related to *Quercus neriifolia* (Braun), a species plentifully found at Oeningen. (Nanaimo.)

5. *Quercus Evansii* (Lsqx.). Leaves thick, coriaceous, half a foot long or more, elliptical, with wavy and entire margins. Primary and secondary nerves deep and broad, apparently keeled. Secondary nerves oblique, curved along the margin of the leaves. This species has the same form and nervation as *Quercus undulata*, *integrifolia*, *ovalis*, and *platyphylla* of Göppert, all species which may be referred to the same and found in abundance at Shossnitz. The size of our species is twice larger. (Bellingham bay.)

6. *Quercus Gaudini* (Lsqx.). Leaves oval-lanceolate in general outline, narrowed and somewhat decurrent at the base (sometimes rounded), sinuate, dentate above, entire below, pointed. Nerves deeply marked like the former. Apparently a very variable species, which but for the size of the leaves could be referred to the former. Among our living species, its nearest relative is *Quercus densiflora*, a species of California. (Bellingham bay.)

7. *Quercus platinervis* (Lsqx.). A very large leaf, of which fragments only were collected. It is apparently elliptical, thick, with undulate or irregularly sinuate and toothed margins. Primary and secondary nerves broad, deep, flat; secondary nerves oblique and branching above the middle; surface wrinkled by the deep tertiary and perpendicular nearly percurrent veinlets. Related to *Quercus platanoides* (Göpp.) found at Shossnitz. (Nanaimo.)

8. *Planera dubia* (Lsqx.). Leaves short oval, petioled equally serrate on the margins. Secondary nerves simple, close, running to the point of the teeth. This species is so much like *Planera Ungeri* (Braun), which characterizes the European tertiary, that it is not possible to point out a difference. It may be identical. (Bellingham bay.)

9. *Ficus?* An undeterminable species of which the broken base only is marked on the specimen. By its wavy, entire, and irregular base, and its peculiar nervation, it is referable to *Ficus populina* (Heer), of the Lower Miocene of Switzerland. (Nanaimo.)

10. *Cinnamomum Heerii* (Lsqx.). Leaves elliptical or obovate, slightly decurrent at the base on a broad petiole. Lateral nerves ascending to the top? with obsolete divisions. The genus *Cinnamomum* is largely represented in the Miocene of Europe and appears to be equally so in the tertiary strata of our northwestern continent. The species above described is nearly if not perfectly identical with *Cinnamomum Buchii* (Heer), abundant in the Molasse of Lausanne, Switzerland. (Nanaimo.)

Two fruits of the same genus were found among the specimens of Dr. Evans.

11. *Cinnamomum crassipes* (Lsqx.). Leaves very thick, cuneiform, rounded at the base, with entire margins decurrent on a broad petiole or enlarged medial nerve. Nervation acrodrome, viz., the three principal nerves ascending to the top of the leaf from the acute angle of divergence at the base. Veinlets scarcely visible. The specimens collected all show only the inferior part of the leaves, even without the petiole. But the relation of the species with *Cinnamomum Rossmæsleri* (Heer) of the Miocene of Switzerland, is evident enough. (Bellingham bay.)

12. *Persoonia oviformis* (Lsqx.). Leaves oval-coriaceous, shining or smooth; secondary nerves alternate, the basilar one ascending to above the half of the leaf. Veinlets indistinct. The part of a leaf here described might be referred to *Cinnamomum subrotundum* (Heer), a species most extensively distributed in the Miocene of Europe, but for the basilar secondary nerves which are alternate. It belongs beyond doubt to the Proteaceæ and to the genus *Persoonia*, but I do not know of any species to which it is related. (Bellingham bay.)

13. *Diospyros lancifolia* (Lsqx.). Leaves shining, oval, lanciform, taper-pointed at both ends, entire, petioled. Secondary nerves alternate, strongly marked, somewhat arched and in acute angle with the medial nerve. Veinlets obsolete. The species agrees well with *Diospyros brachysepala* (Al. Br.), common at Oeningen. (Bellingham bay.)

14. *Acer trilobatum?* (Al. Br.). Is the most abundant species of the Miocene of Europe, and I refer to it with doubt two specimens on which except the obtuse sinuses and the nervation, the outline of the leaves is not preserved. (Bellingham bay.)

With the above species I must also mention some leaves which could not be well determined for want of good specimens. A *Platanus?* with the same nervation as *Quercus platinervis;* a *Chamærops* agreeing with *Sabal Lemanonis* Brgt., common in the European Miocene, or rather a true characteristic plant of the tertiary; a very fine *Salisburia*, very variable in the outline of its leaves and named *Salisburia polymorpha* (Lsqx.), distantly related to *Salisburia adianthoides* (Ung.), found in the Pliocene of Italy; a small piece of a fern referable to the genus *Lastrea*, all these found at Nanaimo; and further a branch of *Sequoia*, apparently identical with *Sequoia sempervirens* (Endl.), still living in California. It was found on a piece of coarse sandstone at Coosa bay. A species of the same genus, viz., *Sequoia Langsdorfii* (Heer), is very abundant in the Miocene of Europe, and is so near a relative of *S. sempervirens* that M. Heer doubts if it is not the same species.

From the truly magnificent work of Prof. Heer (the Fossil Flora of the Tertiary), we see that the Shossnitz formation which was formerly referred by Prof. Göppert to the Pliocene belongs to the Upper Miocene; and that the fossiliferous strata of Heering in Tyrol and of Sotzka in Dalmatia, placed by M. Unger in the Eocene, must be admitted as Lower Miocene. Therefore, except the *Salisburia*, which would perhaps indicate a newer formation by its analogy with a species of the same genus found in the quaternary of Italy, there is not in Dr. Evans's collection a single plant that does not show a near relation to some species of the Miocene of Europe. The geological position of the coal strata of Vancouver and of Oregon where the leaves have been found is thus evident. This conclusion is not new; but it is worth remarking how closely the fossil plants characterizing the formation in Europe are analogous to those of North America.

On the coal itself, in connection with these leaves, Dr. Evans has given the following remarks already published in the National Intelligencer. "These coals do not belong to the true coal measures but to the tertiary period; they have however been altered by volcanic action. The Bellingham bay coal particularly, in consequence, is of a remarkable crystalline structure and presents under the magnifier a very singular and beautiful appearance. It will produce an excellent coke, and is well suited to manufacturing and domestic purposes. It burns freely and although rather light for long sea voyages, unless the construction of furnaces should be changed, lessening the draft, is suitable for river navigation. The coal crops out at various points from the British line to near Port Oxford in Oregon, and is accessible to sail and steam navigation, and almost inexhaustible in quantity. These coals with imperfect machines and fa-

cilities for mining can be delivered ready for shipment at from $2 to $3 per ton.

"The average analysis of many specimens gives the following results:

Fitzugh's Mine, Bellingham Bay.

Specific gravity,	1·346
Carbon in coke,	60·23
Volatile gases,	26·85
Moisture,	10·51
Ashes,	1·94
Sulphur,	·47
	100·00

Bigelow's Mine, Dwamish R.

Specific gravity,	13·78
Fixed carbon in coke,	54·01
Ashes,	9·00
Volatile gases,	26·33
Moisture,	10·66
	100·00

Coosa Bay.

Specific gravity,	13·84
Carbon in coke,	59·30
Volatile gases,	25·50
Moisture,	9·50
Ashes,	5·70
	100·00

Species of Fossil Plants collected near Sommerville, Fayette Co., Tenn., by Prof. J. M. SAFFORD, State Geologist of Tennessee.

The species of this collection that are referable to plants of our time are only four.

1. *Laurus Caroliniensis* Mchx. (Red-bay). Grows now in the swamps from South Delaware and South Virginia to the two Floridas, in pine barrens.

2. *Prunus Caroliniana* (Michx.). Wild orange tree; a species now confined to the islands and near the coasts of Carolina, Georgia, &c., and in the Bahama Islands where it is at its true latitude. Michaux remarks that this species is not found on the main land at a distance of two to ten miles from the shores where the temperature is five to six degrees colder in the winter and proportionally milder in the summer.

3. *Quercus myrtifolia* (Willd.). Inhabits now the islands south of Georgia and along the coasts of Florida.

4. Fruit of *Fragus ferruginea* (Michx.). Red beech. This fruit is somewhat more distinctly ribbed on the sides and margins than in our common species, but the characters are not distinct enough to permit a separation of species. The range of the American beech is rather northern. It is found to the south along the Alleghany mountains.

The following plants of Prof. Safford's collection are either new, viz., extinct or undescribed species, or unknown to me.

1. *Salix densinervis* (Lsqx.). Leaves narrow, one and a half to two inches long, lanceolate or tapering at both ends, entire. Medial nerve inflated at the base. Secondary nerves very close, anastomosing as in the leaves of a fern or of a *Trifolium*. The nervation is quite peculiar for a *Salix*, and perhaps when better specimens are found, the plant may be referred to another genus.

2. *Quercus! crassinervis?* (Ung.). The specimen is broken and shows only the middle part of a large, sharply dentate leaf, apparently oval-lanceolate in outline. The *broad nerves* and secondary nerves running to the point of the teeth as the form of the acute teeth also would refer this species to *Quercus crassinervis* Ung., a species found in the Upper Miocene only.

3. *Quercus Saffordii* (Lsqx.). Leaves nearly linear, less than one inch broad, five to six inches long, gradually tapering to a point. Margins regularly and distinctly mucronately serrate, entire near the base and decurrent in a broad petiole or enlarged nerve. Medial nerve broad and flat; secondary nerves oblique, straight, running to the point of the teeth and alternating with short and slender ones. There is not any published fossil species that might be compared with this. It is distantly related to living species of southern Texas and Mexico, but among the leaves kindly furnished to me for comparisom by Dr. Asa Gray, there were none of these new species to which it could be referred.

4. *Andromeda dubia* (Lsqx.). A thick, smooth, elliptical, obtusely pointed leaf, with entire, wavy, and somewhat reflexed margins and obsolete nervation. It is nearly related to *Andromeda ferruginea* (Michx.) of the pine barrens of the south. This near relation would indicate that the true identical species might be found on the islands or along the shores of the Southern States.

5. *Andromeda vaccinifoliæ affinis.* Thick, oval, lanceolate, pointed or obtuse leaves with perfectly the same size, outline and nervation as the above mentioned *A. vaccinifolia* Heer. Its nearest living relative in America is, I think, *Andromeda acuminata.* But the leaves of the fossil species are smaller and the nervation somewhat different. *A. vaccinifolia* belongs to the Upper Miocene.

6. *Elæagnus inæqualis* (Lsqx.). Leaf long, elliptical, obtuse, with entire margins, rounded near the base on one side, and about one inch longer and decurrent on the other side of the short petiole. Secondary nerves well marked, thick near their base, emerging in acute angle, with a camptodrome much divided nervation. I do not know of any living species to which this could be compared. Among the fossil plants its nearest relative is *Elæagnus acuminatus* (Web.) found at Oeningen.

Fossil Leaves collected in the chalky banks of the Mississippi River near Columbus, Ky., by Dr. D. DALE OWEN and L. LESQUEREUX.

1. *Quercus virens* (Michx.). Live oak. The leaves of this species are abundant in the strata. On this oak Michaux remarks that its range of habitat does not extend to more than ten to fifteen miles from the shores of the sea in the Southern States.

2. *Castanea nana?* (Muhl.). Our leaf is somewhat narrower than generally found in this species, which now inhabits the pine barrens of the south.

3. *Ulmus alata?* (Michx.). This species is also mentioned with some doubt. Our leaf is more pointed and its teeth shorter. It might be only a variety of *Ulmus Americana*. The only specimen is deficient.

With the above species there is another *Ulmus!* scarcely one inch long, ovate, with nervation and form of teeth of the genus, which exactly resembles *Ulmus minuta* (Göpp.) of the Upper Miocene. Perhaps it may be a variety of the following species. But it differs evidently in its simple teeth and the rounded base of the leaves.

4. *Planera Gmelini* (Michx.). This species grows now in the river swamps of Louisiana.

5. *Prinos integrifolia* (Ell.). Two leaves of this species were found in the chalk banks. They agree in every point with the *Prinos* still living in Florida.

6. *Ceanothus! Americanus?* (L.). To this very variable and common species, I refer with some doubt two leaves, one large, regularly ovate-obtuse, with somewhat decurrent margins, the other oval-lanceolate, with rounded base. The nervation and serrature of the leaves are just alike and agree with *C. americanus*.

7. *Carya olivæformis* (Nutt.). Pecan. Fruit and leaves in specimens. The geographical habitat of this species is still the same as of old.

8. *Gleditschia triacanthos* (L.). A few detached leaflets evidently belonging to the Locust.

9. *Acorus calamus* (L.). Part of a broken leaf.

10. Some undeterminable catkins of *Alnus* or *Betula*.

The remarks of Prof. D. Dale Owen in the first volume of the Survey of Kentucky, p. 22, indicates the position of the strata bearing these fossil leaves as being about 120 feet lower than the ferruginous sand in which the bones of the *Megalonyx Jeffersonii* were found. The exact position of the strata near Sommerville has not been exactly determined by Prof. Safford. But from the species of plants of his collection, they are referable to the lower or middle Pliocene.

If we now examine the general distribution of the plants enumerated above, we are at once struck with the remarkable character of the Miocenic flora of Oregon and Vancouver Island which evidently indicates a tropical climate at this period of the geological formations. Palm trees, figs, Cinnamomum, and Proteineæ are now generally distributed at least 30° lower than they were then. But it is still more extraordinary to find just on the same latitude but on an opposite point of the globe, in Switzerland, a contemporaneous fossil flora of which the species have so near a relation to those of Oregon that some of them may be regarded as truly identical. This shows a remarkable uniformity in the direction of the isothermal lines at the epoch of the Miocene formation, and establishes beyond a doubt that

the oscillations of temperature have been generally marked around our globe and have not been the result of local geological disturbances. That the oscillations were slow and progressive is shown by the distribution of the species of plants in both the following formations. In the Miocene of Vancouver the Proteineæ are dominant. It has also palm trees and Salisburia, all tropical plants, and most of the species are without relation to the plants now living on this continent. In the Pliocene of Tennessee the Proteineæ appear still abundant and the flora finds its relatives in the southern shores of Florida and on the islands of the Gulf of Mexico. The Post-pliocene of the Mississippi near the mouth of the Ohio river, and even above it, has the same species of plants as are now found along the shores of the Atlantic, in the southern states. We have thus apparently a steady decrease in the temperature from the Miocene to the Post-pliocene of the Mississippi. From this it appears to follow that the chalky banks of which the true geological position is still uncertain, ought to be regarded as anterior in origin to the Drift. For it is probable that if they had been deposited after or at the time of the ice period, the distribution of the plants would show a colder climate rather than the climate of our southern shores.

ART. XL.—*On Bornite from Dahlonega, Georgia;* by Dr. C. T. JACKSON.

BORNITE occurs in Field's gold mine, in Dahlonega, Georgia, in a vein of quartz, associated with native gold and some auriferous iron pyrites, in hornblende slate rocks, bordering the Chestertee River.

The mineral is found in thick foliated masses, having a crystalline structure probably hexagonal, though not perfectly defined. The masses are from half an inch to one inch in diameter, and they split like talc and mica into thin plates, quite as readily as talc.

Its lustre and color, are like those of highly polished steel. It is flexible, sectile, and soils the fingers like plumbago or molybdenite. Its streak on porcelain is metallic, or near the color of the pulverized mineral. Hardness between that of gypsum and calcareous spar, but nearer to the former, say H. = 2·25. Density 7·868. Before the blowpipe on charcoal melts, giving out white fumes, which have the odor of selenium, leaves a white deposit on the cold charcoal, and near the bead a ring of yellow color, and a little metallic bismuth is obtained.

This, cupelled, gives a little gold. In an open glass tube no smell of sulphur observed; a white smoke fills the tube, and condenses in it. Heated, this deposit forms little yellowish globules. At the lower extremity of the tube, a fused metallic mass remains adherent to the glass. A little brown sublimate is mixed with the sublimed telluric acid, and is selenium.

One gram of this mineral selected with care, to avoid all admixture of pyrites, was analyzed and the following results were obtained:

Bismuth, (BO. 0·88)	0·7908
Tellurium, (metallic)	0·1800
Selenium, ($BaO+SeO^3$ 0·042)	0·0118
Gold, (mechanically mixed in fine scales)	0·0060
Loss,	0·0114
	1·0000

The bismuth was separated from the nitric solution by carbonate of ammonia, and was several times redissolved and precipitated anew, to free it from all traces of telluric acid. It was then converted by heat, in a porcelain crucible, into oxyd of bismuth. The whole of the washings and the filtrate, mixed, was evaporated to small bulk, and the nitric acid was decomposed and removed by repeated additions of chlorhydric acid and heat until no more chlorine was given off. Then the solution was brought to near neutrality by ammonia and a current of sulphurous acid gas was passed through it, until all the tellurium appeared to be reduced. It was then filtered and washed with water saturated with sulphurous acid, and the filter which had been properly tared was weighed, when dry, at 212° F.

On addition of a solution of sulphite of ammonia to the filtered solution, and allowing it to stand for forty-eight hours, more metallic tellurium subsided, and was collected in a tared filter and the amount was added to that first obtained. Standing twelve hours longer this solution gives no more deposit, though it smells strongly of sulphurous acid gas.

The selenium was determined on a separate sample, of one gram of the Bornite, by converting the selenium into selenic acid, by prolonged digestion in nitro-muriatic acid. Then the selenic acid was precipitated by nitrate of baryta, as seleniate of baryta. It weighed 0·042 gram.

By separate experiments, it was ascertained that no sulphuric acid existed in the solution of the Bornite; hence no sulphur was present.

Boston, March 12, 1859.

Art. XLI.—*Geographical Notices.* No. VII.

Physiography of the Isthmus of Chocó, New Granada. By Arthur Schott.*—The transit line across the Isthmus of Chocó, New Granada, has been lately re-surveyed, from ocean to ocean, in the neighborhood of the seventh parallel of north latitude, by a party acting under the authority of the U. S. government. The following facts were collected in connection with the field work of the topographical party, under the immediate orders of Lieut. N. Michler, U. S. Topog. Engineers, coöperating officer of the expedition. A more general account of the results of the survey was given in this Journal, November, 1858.

The entire length of the route surveyed is about 160 miles, belonging entirely to the torrid zone, as its greatest elevation does not exceed 1000 feet above the level of the sea. By its physical features this line is divided into two distinct portions, differing from each other both in extent and in meteorological condition. The western or Pacific slope, being only 15 miles long, has an almost constantly dry climate, which appears to be peculiar to the whole extent of the Pacific coast. The eastern or Atlantic slope, 147 miles in length, situated under a sky perpetually clouded, is drenched for eight or nine months of the year by daily rain, more or less heavy. Its atmosphere at the same time is kept in a state of perpetual oscillation by never-ceasing electric changes. Along this portion of the line, the features of the country are decidedly aquatic, varying according to the hypsometrical subdivisions.

From the level of the salt water in the Gulf of Urabá to its marshy uplands and scarcely ventilated mountain forests, every kind of "lowland" is represented,—mangroves, lagoons, everglades, forest swamps and ever-shady uplands.

To facilitate a more detailed examination of the country the following synoptical table is submitted: I. Mangroves and tide-water lagoons. II. Atrato levees. III. Everglades and overflow of the Atrato. IV. The palisades. V. The lowland. VI. The tableland. VII. The Cordillera or Divide. VIII. The alluvium. IX. The mangroves. X. The beach (La Playa).

Not only is the Atlantic slope found at first sight to exceed very much in extent the western or Pacific slope (a feature which applies generally to the whole of the continent,) but also each of the topographical subdivisions mentioned is much more developed on the eastern side than on the western. Throughout almost the entire route, the aquatic character already referred to is distinctly marked in its fauna and flora. A more detailed review

* Communicated for this Journal by permission of the U. S. Navy Department.

commencing on the Atlantic shore in the Gulf of Urabá may be added to the table just given.

Section I. *Mangroves and Tidewater Lagoons.*—Among plants we find prevailing here Rhizophoreæ, aquatic Gramineæ, Polygonaceæ, Aroideæ, lacustric Palmaceæ and Musaceæ, all which by habit correspond to amphibious reptiles, to Natatores and Grallatores among the birds or to the cetaceous Manati, and to fluviatic Cavidæ like the Agouti and Lancha (Dasyprocta and Hydrochœrus). As occasional forms of animals we here find the red roaring monkey (Mycetes seniculus), and of birds two forms related to Sturnidæ, which suspend their nests from the branch-tops of the mangroves, thus making them inaccessible to their enemies. To these may be added a genus of Psittacidæ in the shape of the psittaceous Macao. These birds leave their home in the more elevated regions on the eastern shore of the gulf, to follow their daily sport all over the Atrato delta, which in the evening they leave again. Nearly related, anatomically, to the Scansores are the Halcyonidæ, and we may rightfully consider them as icthyophagous climbers. They are represented by three or four distinct species, and form a characteristic type along the whole line.

This section, of an extent of about twelve English miles by way of the river, may be characterized geologically as floating alluvium, which is covered by a low but densely interwoven arboreal vegetation.

Section II. *The Atrato Levees.*—Where the surface of the country rises up to and above high-water mark, plants of more terrestrial habits are added to the former. Thus Leguminosæ with their suborders Cassieæ and Mimoseæ, also Malpighiaceæ, Malvaceæ, Euphorbiaceæ, Apocynaceæ, Margraviaceæ, Lecythidaceæ, Melastomaceæ, Bignoniaceæ, and others, are met with under a most diversified generic display. While these orders are so varied in habit, and the division of Scandentes is a prevailing type, we find a close analogy to them in the members of the fauna inhabiting this ground. Among the reptiles we observe the Iguano and the Basilisc, both of arboreal habits and only occasionally taking to the water. The Quadrumana generically increase. Mycetes Beelzebub and Pithecia leucocephala (the Zambo and the Mono cara blanca) appear with the roaring monkey. Here also the low form of Bradypus finds a safe and solitary retreat. Among the birds, the Scansores, the most appropriate form for this section of country, are represented by almost every variety. The carpophagous Psittacidæ, the entomophagous Picidæ, and the sarco- or at least oö-phagous Ramphastidæ are leading forms, together with the ichthyophagous

Halcyonidæ and the Anhinga which is a Pelicanid of arboreal habit.

Keeping step with the gradual elevation of the country the fauna and flora increase. Musaceæ and Amomaceæ, with their peculiar maximum development of chlorophyllum, may be considered as equivalents of the two herbivorous pachyderms, which seem to feed on them; they are the tapir and the peccari (Danta and Sajino of the natives). Corresponding to them is the Manati, which is said to abound through this section as it does also within the delta.

The section of the Atrato levees in its geological character is, if the expression is admissible, truly amphibious, for during eight or ten months it is thoroughly swamped by the overflow of the Atrato.

The growth of trees upon it is nevertheless very heavy, and the traveller here meets those well known mighty leguminous giants in company with mammoth forms of Bombax ceiba, and also with Cedrela, Carolinea or a Tecoma. They maintain a prominent stand upon the banks of the river or arrange themselves there in closed ranks as an impenetrable phalanx.

Here the river flows in solitary grandeur, reflecting from its mighty sheet of water an ocean of light and giving freedom to the aerial currents, which show their effects in the surpassing beauty of a tropical flora. Such is the difference, where light and air have access, that even the plague of mosquitos and the lurking effects of sickly miasms, which have their dominion within the enclosures of the swampy forests, disappear upon the openings of the river.

It is a peculiarity of the Atrato that it forms, throughout its course of nearly sixty miles from the head of its delta up to the mouth of the Sucio and still higher up, but one bed, within which it keeps collected the whole body of water, bordered by vertical banks and having an average depth of over fifty feet.

The Atrato levees are scarcely inhabitable. Even the Indians and few Zambos remain upon them only occasionally for temporary fishing and hunting. The only settlement is found at Sucio, and this is but a mere trading station for the Atrato navigators and a shipping depot for the collected raw material of caoutchouc and ivory-nuts. A few natives only remain in this place to profit by raising plantains, bananas and other fruits, Indian corn, calabassas and cacao, which latter prospers here and is of superior quality.

Section III. *The Everglades.*—In leaving the Atrato levees through the mouth of the Truandó a relapse of level is reached, which leads for about 18 or 19 miles through a region of everglades. They form on both sides of the Atrato the recipients

of the river's annual overflow. Here forest-vegetation is almost entirely checked by the eddying currents of the main river and its tributaries. Only certain swells of the bottom or levees bordering on running streams are indicated by the growth of larger trees, and so we recognize here those vegetable causeways called caños or calles by the natives, or regular hummocks in the shape of small bushy islands, which stud this vast grassy ocean.

This region is preëminently aquatic and characterized as such by its animal and vegetable forms, among which the "waders" prevail. The trees wear the same mournful adornments as the cypresses do in the dismal swamps of Louisiana or the Carolinas. Long flakes of Tillandsia usneoides are suspended from the tree-tops, playing in the wind like nature's funeral streamers. In many of the trees life seems to be extinct, and a host of parasites and pseudo-parasitic heirs have taken possession of their leafless branches and withering trunks. Here we find a variety of dendricolous Filices, Musci, Jungermanniaceæ, Hepaticæ, Lichenes, Bromeliaceæ, Aroideæ, and Orchidaceæ.

Numerically the most prominent vegetable forms are a Polygonum and a Panicum (the Gramalote and the Tabaquillo of the natives). They are frequently interspersed with a conspicuous arborescent Aroid (perhaps the poisonous Caladium arboreum) in company with which they often stand in from three to ten feet of water. The margin of such growth appears frequently lined with patches of Pontederia azurea (perhaps crassipes?) and the graceful floating Desmanthus lacustris, the Dormidera or sensitiva Nadadora of the natives. Both the latter forms are of migratory habits, and the traveller on the Atrato often meets them in the form of large floating islands, upon which little herons and the neat Parra Jacanna have their sport after insects and waterworms.

Corresponding to the dense herbaceous cover of the everglades in which millions of ichthyophagous alligators are found, is the generic and numeric display of wading birds. Among them the most prominent for its size is the herbivorous Cabrilla of the natives (Palamedea chavarilla). Scansores are also fully represented, and also some Conirostres of which the most interesting are a Crotophaga, a Cassicus (cristatus?) and a Tanagra. Of mammals only Mycetes seniculus was noticed.

The everglades are uninhabited, and from their nature will necessarily remain so.

Section IV. *The Palisades* (*Las palizadas*).—If we consider the everglades as a fresh water repetition of the tide-water lagoons below, the section of the so-called palisades may be looked at as corresponding to the Atrato levees only with this difference, that

they are not traversed by a wide running stream like the Atrato but by a multitude of minor rivers and bayous, from which air and light are more or less excluded by the over-lapping branches of the great forest covering it. Consequently we here meet a marked generical decrease of organic forms, when compared with the vegetation upon the banks of the Atrato.

The palisades thus form a belt of forest swamps, which borders the everglades to the west and covers the eastern limits of the sloping lowlands.

If we do not find here that magnificent display of individual development in organic forms which was noticed upon the Atrato levees, we still find a great increase both in species and number, when compared with the lagoons. Here forms of the most diverse nature are thrown together and flourish in closest contact. The same feature is repeated also in the animal kingdom.

Plants and animals of more terrestrial habits enliven this nocturnal region, where the sun never reaches to the bottom, and where not the slightest breeze penetrates beneath the tree-tops.

For this reason the higher forms of mammals are confined to but few orders, as Felidæ, Quadrumanæ, and Sciuridæ, which are naturally fit for arboreal life, and thus avoid the dark swamps below. A far greater increase was noticed among the feathery tribe, among which we find represented: Accipitres, Conirostres with a considerable variety of Buccidæ, Rasores, Columbidæ, Merulidæ, Tenuirostres, Trochilidæ, Muscicapidæ of every shape and size, Sylphiadæ and Scansores, whilst others as certain Rallidæ and Ardeidæ take leave. Of the Rail family, however, the remarkable "Psophia crepitans" seems to be still retained.

The geological character of this alluvial section is peculiar, for within its limits fallen and drifting timber forms a sort of a skeleton for the more firm though only temporary support of an otherwise incessantly shifting soil. This same timber, however, which causes such "*ground-mooring*" produces on the other hand a great number of obstructions to the navigation upon the "*subsylvatic*" branches of the Truandó river and its affluents. This characteristic of the palisades undoubtedly gave rise to the Spanish vernacular name "las palizadas," which signifies any place naturally or artificially defended by fence-work. The name is certain well chosen, for it applies as well to the hydrography as to the topography of the region.

Like Section II, the palisades are scarcely inhabitable, and only a few families of Chocóes (Indians) occasionally build here their temporary lodges, as their hunting and fishing or migrations may require. The cross extent of the palisades amounts to about 14 miles.

Section V. *The Lowland.*—Closely allied to section IV. are the lowlands with an east to west extent of about fifteen miles. The geological physiognomy of this belt differs from that of the palisades only by having a more inclined surface. The upholding strata towards the west end of the section exhibit more or less disturbed, often broken and isolated layers of tertiary rocks.

Nature's means for producing the most surprising results appear often very trifling. Here a slight increase of the angle of inclination changes almost the whole physiognomy of the surface. The Truandó, before divided into endless branches and sweeping like a many-headed Hydra through the nocturnal forests below, now gathers its waters into one bed. Its winding course is bordered by more elevated banks, which are crowned alternately by the growth of heavy timber or densely interwoven brushwork, or appear lined by patches of succulent Endogens of the orders of Musaceæ, Amomaceæ and Gramineæ, whilst the whole seems to be festooned all over with the rich garlands of a perpetual festival.

The general increase of vegetable forms through this section becomes especially marked with Filices, of which nearly all throughout the lower sections have been dendricolous. Now quite a number of forms are noticed to be terricolous within the lowlands. At the same time other orders, as Orchideæ and Aroideæ, decrease in a similar ratio as others increase.

Similar changes take place in regard to animal life. Several species of Rasores and Columbidæ appear in addition to those families observed along the Atrato banks.

Alligators seemed to be lessened in number, probably in consequence of the reduced space, occupied by water. These carnivorous Saurians seem to ascend the rivers of the country to deposit their eggs in the warm sand along the streams, thus securing their offspring above overflow, during the dry season.

The elevation of this section seems to justify somewhat, human habitations within its limits. Thus we find in its western portion one tambo? (station house of the Indians) near the mouth of the Salado, a little tributary of the Truandó. This locality is also oryctognostically marked by a fossiliferous metamorphic limestone? which in all probability will answer the purposes of a first class building stone.

Section VI. *The Table-land.*—At the western margin of the Lowland a rocky terrace rises, the steep side of which faces east. Upon the top of it the table-lands of the upper Truandó and Nercua are placed. The position of the various strata constituting these table-lands are augitic (perhaps trappean) rock, either strongly granular crystalline or compact amygdaloid or

porphyritic in texture, and schistose in structure. Layers of an argillaceous sedimentary rock of little specific gravity, stratified but bearing marks of disturbance, since their original deposition are overlying the former. In the bed of the river, erratic and drifted boulders of concretionary or semi-rock occur. Alluvium uniformly covers the whole. The lower strata are only exposed at the east end of the section and partly along the Truandó. From the mouth of the Nercua upwards only quaternary deposits are standing out.

The upheavings of the metamorphic rocks rise to a height (approximately of from 250 to 300 feet) above the waters of the Truandó; and form here a series of falls and rapids, the river rushing through the narrow pass of this formation for the distance of about three miles.

This catenary mountain range, made up of this rock, seems to be a northeasterly outrunner of the Cordillera to the west, and has received from the surveying party the name "Sierra de los Saltos;" for under the vernacular name "Saltos" this region is known to the natives.

Not only within the enclosures of the mountain pass of the Saltos, but all through the table-lands and their next vicinity below, more distinct potamographical features are perceptible. They consist of a number of real tributaries, each one draining a regular basin of its own. This is quite different from the swampy sections below, the whole extent of which is to be considered as a common estuary, where all the affluents of the Atrato and Truando lose their identity beneath the dead level of a network of lagoons and sloughs.

On the western limits of the table-land interesting signs of a volcanic axis were observed in some thermal springs, one of which was found to have a temperature of 107° F. Here the water is saline and smells like carburetted hydrogen.

On the surface of the table-lands the array of vegetable and animal forms, reaches its highest pitch of development. This undoubtedly is the result of a more thorough ventilation and insolation of the country, in addition to a better regulated drainage, and a diversified sloping of the surface. It is this section only, which a few families of Chocó Indians have taken as a permanent abode, to follow, though constantly roaming, their semi-agricultural pursuits.

Here also the plague of mosquitos and sandgnats ceases gradually; but now the traveller has to guard against the almost imperceptible aggressions of the "nigua" (Pulex penetrans).

Articulata in general appear still more diversified, especially Apidæ, Formicidæ and Cimicidæ, as also a great number of wood-destroying Coleoptera. Xylocolous and troglodytic Arachnidæ, become quite a prominent feature, while the Lepidopteræ

and Neuropteræ, the beau monde among insects, display their utmost.

Reptiles also appear in full force with the exception of the alligators, which seem to prefer their sport through more aquatic regions. New forms of fish also appear, as if to exceed the superabundance of the regions below.

Aphidæ have rarely been met with, and only few were collected. The flora is also further enriched by several genera and species of palms, which did not occur below; Areca, Phytelephas, Carludovicea appear strongly represented. A still larger addition however is to be mentioned as regards ferns, which now according to their habitat may be classed as Terricolæ, Saxicolæ, Dendricolæ, and subdivided again into Insedentes, Scandentes, Ripariæ.

It will be observed that no mention has been made of the higher orders of Vertebrata being represented here, though there is no doubt that such is really the case. The scanty means of our travel generally, but especially through this and the following sections, permitted but imperfect observations on this point. One deer was observed however by the majority of the party, and so a member of the Ruminantia, (one of the most interesting orders and apparently rare throughout,) came to be noticed. As the table-lands are inhabited by hunting Indians, the representatives of higher animals, must necessarily be limited.

The line of travel through this section, amounted to about 30 miles.

Section VII. *The dividing ridge.*—The dense and unbroken forests covering this low sierra or cordillera, as some call it, are characterized by a numeric prevalence of palms and quite a selection of "Filices" not seen before. Among the latter several so-called flowering ferns appear. Otherwise a marked decline as well in generic as also in numerical development of floral forms was observed. This is probably caused by a lessened drainage. The head of the last Atlantic stream, Hingadór, is remarkable for the occurrence of several beautiful examples of an arboreous fern, (probably a Cyathea?) attaining a height of from 25 to 30 feet. A second terrestrial orchid came into notice through this section.

With animal forms the general decrease is still more perceptible, and larger animals do not seem to exist here at all, with the exception of the peccari.

A well beaten Indian path loosely connects the Indians on the Nercua with a Zambo settlement on the Pacific shore, which may also account to some degree for the general scarcity of game.

In its geological features the dividing ridge bears some analogy to the structure of the table-land. A similar trappean rock of a schistose texture, perhaps less compact, underlies a deep quaternary bed. Between both, traces of tertiary layers may be discovered by parties better fitted out for exploring purposes than we were.

In the bed of small streams on both sides, an argillaceous deposit of quite recent origin, and a calcareous conglomerate (nagelfluhe) containing coarse sand cemented together with a mortar-like matrix, were observed covering the metamorphic rock beneath. The alluvium sustaining a dense and heavy forest vegetation, made it very difficult indeed to bring out clearly the geological structure of this section.

Except in the beds of the small streams, rocks were nowhere observed. Nothing of the more solid frame of the dividing ridge was discovered except at the head of the Hingadór falls, and on the other side on the banks of the "Pie de Nercua." On the latter place, rocks in situ were seen nearly related to those on the Truandó falls.

The prevalence of terrestrial plants against aereal and arboreal forms observed through the lower portion of the Atlantic slope may justify the idea of supposing the crest of this dividing ridge to be likewise a water-shed and a meteorological divide between both oceans.

This section, though not uninhabitable, is not populated at all; it looks more like a neutral ground between the quiet Indians and the adventurous Zambos on the other side.

The distance travelled across this section is about 7·5 miles.

Section VIII. *The Alluvium.*—This section forms a narrow belt linking together the western slope of the dividing ridge and the tide-water flats below. There seems to be an increase of atmospheric humidity, which produces vegetable increase again. The generic and numeric animal and vegetable forms lost before are somewhat regained, but the region itself is of too little extent to sustain again that opulence which was observed through the corresponding sections on the Atlantic side. It is true the fauna may have been intruded upon by the population of the seaside near by.

This section also contains a number of clearings (rozas) for the cultivation of tropical field and garden fruits, which indeed is fairly commenced by the Zambos.

The width of this alluvial belt, as it was travelled over, is about three miles.

Section IX. *The Mangroves.*—This section is entirely and almost exclusively rhizophorous, much more so than its equivalent on the Atlantic side. In regard to the individual growth

of this remarkable tree, I have seen nowhere in all my travels mangle columns of such size.

One species of fern within this section descends to the tide-water mark in the same way as another species of apparently the same genus on the Atlantic. These two sea-side ferns thus may be looked at as the alpha and omega of filical growth, holding respectively both termini of the isthmus line.

The fauna rapidly decreases, clearing the scene for only a few orders and families of lower organization.

The travelling line through the mangrove belt amounted to about two miles.

Section X. *The Beach* (La playa of the natives).—This narrow peninsular neck of land is separated from the main by a narrow bay. It is a mere gain from the salt water, made by the free beat of the ocean wave, the maximum rise of which amounts to about fifteen feet.

The formation of an eastern equivalent within the Gulf of Urabá seems to be prevented there by the peculiar stowage of the waters, which hold the gulf shores in a continued state of submersion, where the tidal movements do not change over two feet.

The open beach on the Pacific forms the Peninsula of Paracuchichi, named after one of the three rivers emptying their waters into the ocean in its immediate neighborhood. In fact the seaward tendency of their currents has been the principal agency in the formation and partial detachment of this continental appendix, as we may call this peninsula.

The top of this beach above high-tide mark is crowned by a dense growth of brushwork, sparingly interspersed with single trees of larger size, and outwardly lined by a dense row of magnificent Cocos palms.

The fauna upon this outlying flat is entirely littoral and but poorly represented.

The flora is a motley growth of seashore plants and continental forms. The orders of Apocynaceæ, Bignoniaceæ, Cassicæ, Mimoseæ and Leguminosæ are general, also Passifloraceæ, Solanaceæ, Convolvulaceæ, and Gramineæ have been observed. Among the latter bunches of a graceful Uniola were very conspicuous.

The distance across the bay (bahia ensenada) and the beach is about three quarters of a mile.

Note.—In what has preceded it should be remarked that the measurements are only approximative, having been taken from rough field notes.

Georgetown, D. C., February, 1859.

LIEUT. WARREN'S PRELIMINARY REPORT OF EXPLORATIONS IN NEBRASKA AND DAKOTA.—Lieut. G. K. Warren, U. S. Topog. Engineer, has prepared and published a preliminary report dated Washington, Nov. 24, 1858, (173 pp. 8vo, Washington, 1859) of his explorations in Nebraska and Dakota. It includes a part of his observations in three expeditions; the first in 1855, when he made a reconnaissance of the Dakota country, especially of the routes between Fort Pierre and Fort Kearney, Fort Kearney and Fort Laramie, hence again to Fort Pierre, and thence to the mouth of the Big Sioux; the second in 1856, when he made a reconnaissance of the Upper Missouri, and of the Yellowstone river as far as the mouth of Powder river; the third in 1857, when under the directions of the Secretary of War, he undertook to determine the best route for continuing the military road between Mendota and the Big Sioux, westward to Fort Laramie and the South Pass, thence to proceed northward and examine the Black Hills, returning by the valley of the Niobrara and making thereof a careful examination. In the last named expedition, the most important of the three, he was accompanied by Messrs. J. H. Snowden and P. M. Engel, as topographers; Dr. F. V. Hayden as geologist; W. P. C. Carrington as meteorologist; Dr. S. Moffet as surgeon; and Lieut. James McMillan as commander of the escort, which consisted of thirty men. The report is divided as follows:

1st. Routes explored, and main incidents affecting the direction and extent.

2d. Physical geography of Nebraska, character of the soil, and resources of the country.

3d. Remarks upon the climate and meteorology.

4th. A description of the principal rivers, and discussion of the merits of different routes. And

5th. An enumeration of the Indian tribes, military posts, and routes for military operations.

It is accompanied by catalogues of the palæontological, mineralogical, botanical, and zoological specimens collected on the explorations, prepared by Dr. F. V. Hayden, so as to show the localities where they were found.

Accompanying the copy of the report which we have received, is a map (referred to in the text as in course of preparation) of all the region occupied by the Dakotas, and the best routes by which to approach and traverse it. In the preparation of this map the materials of other explorers, from those of Lewis and Clark and Long, to those of the Pacific R. R. expeditions, have been employed. It is prepared on a scale of 1 to 1,200,000, and embraces all the country from the 94th to the 106th meridian, between the 38th and 50th parallels. In its northeast corner is the Lake of the Woods, in the southeast Fort Leavenworth, in

the southwest Pike's Peak, and in the northwest the junction of Milk river with the Missouri. A number of rivers are put down on this map which have never yet been explored, except at their mouths; these are the Knife river, Heart river, Cannon Ball river, and Moreau river. But Lieut. Williamson remarks that as the expeditions under his command have gone almost around the section through which they flow, and determined with a great degree of certainty that it is an open prairie, and have gained some knowledge of their lengths and directions from the Indians, they are probably represented with a considerable degree of exactness.

We quote the following general remarks in respect to the physical geography of Nebraska.

"Leaving out of consideration for the present the smaller detached mountain masses, and beginning with the main range of the Rocky mountains, on the 49th parallel, we find their eastern base to have a direction nearly northwest and southeast, and the range crossing the Missouri at 'The Gate of the Mountains.' Continuing southeast, it crosses the Yellowstone near where Captain Clark reached that river in 1806, (latitude 46,) just south of which it forms high, snow-covered peaks. This line of mountains is broken through again by the Big Horn river, and the mountains receive the name of Big Horn mountains. The southeast terminus of the Big Horn mountains sinks into the elevated table land prairie, and the range perhaps reappears again as the Laramie mountains. (South of the latitude of Fort Laramie the line of the eastern front of the mountains is nearly north and south.)

"The Black Hills, whose geographical position we have determined, are the most eastern portion of what has heretofore been considered a part of the great mountain region west of the Mississippi; and it is worthy of note that, if a line be drawn from them to the Little Rocky mountains, on the 48th parallel, which are the most eastern portion in that latitude, this line will be parallel to the line of the main front of the mountains which I have already traced. What is still more significant is, that if a straight line be drawn from the mouth of the Yellowstone to the mouth of the Kansas river, it will also be parallel to the lines before mentioned, and will have about an equal portion of the Missouri on each side of it.

"The line of the east base of the main mountain mass is the highest, of course, of any portion of the plains, and at Raw Hide peak, near Fort Laramie, is about 5,500 feet elevation, as determined by the horizontally stratified tertiary deposits, though owing to great denudation the average height there of this line of the plains will not be so great. The same line, near the 49th parallel, has probably a somewhat less elevation. The lowest line of the plains is that along the Missouri, and its elevation, taken near Bijou Hills, (a point about on the perpendicular to it from Fort Laramie,) is about 2,130 feet, which does not differ materially from its height at the mouth of the Yellowstone. The slope of all this part of the plains (being in a direction perpendicular to the lines of equal elevation) has therefore its line of greatest descent in a northeast direction,

and north of the Niobrara; this is the direction in which a majority of the rivers flow till they join with the Missouri or Yellowstone. To the south of the Niobrara the greatest slope of the plains is to the southeast, towards the Gulf of Mexico, and this is the direction pursued there by nearly all the rivers of the plains. Thus the Niobrara would seem, as it were, to run along a swell or ridge on the surface. The average slope of the plains from the Missouri to the mountains make nowhere an angle with the horizon greater than one-half degree.

"A remarkable feature in regard to this change of slope which occurs in the neighborhood of the course of the Niobrara is the shortness of its tributaries, the surface drainage seeming to be away from and not towards its banks. A result of this is the absence of the amphitheatre-like valley which rivers generally have, and which enable us to look down at the stream often many miles distant. Through the greater portion of the middle half of its course you have scarcely any indication of it as you approach, till within close proximity, and then you look down from the steep bluffs, and catch, at the distance of two hundred to five hundred yards, only here and there a glimpse of the river below, so much is it hidden by the precipitous bluffs which at the bends stand at the water-edge. So strongly was I impressed with the fact that the surface drainage could never have been directed along its course so as to have worn out this channel, that I think a portion of it must have originated in a fissure in the rocks which the waters have since enlarged and made more uniform in size, and which the soft nature of the rock would render easy of accomplishment. It is worthy of remark, in this connection, that the bed of the stream in longitude 102° is four hundred feet higher than that of the White river at the point nearest to this; White river having there cut its way entirely through the tertiary formation, flows along the cretaceous, while the bed of the Niobrara is in the miocene tertiary, the pliocene forming the bluffs. The bed of the Niobrara is also, in two-thirds of its upper course, from three hundred to five hundred feet above the bed of the Platte river at corresponding points at the south.

"In the section of the country through which the Niobrara flows the soil is very sandy, so that what rain or snow falls sinks under the surface, and none is lost by evaporation. This is gradually all poured into the stream by the springs in the ravines, and in this way the river is mainly supplied in seasons of low water, at which times it is one of the largest streams of Nebraska."—pp. 60, 61.

WARREN'S MAP TO ACCOMPANY THE PACIFIC RAILROAD REPORTS.—A map prepared under the direction of the Secretary of War, to accompany the Pacific Railroad Reports has been published on a scale of 1 to 3,000,000, including the country, so far as surveyed, between 26° and 49° N. lat. and 90° and 122° W. long. It is prepared by Lieut. G. K. Warren, U. S. Topog. Eng., acting under the department of Explorations and Surveys, of which Capt. Humphreys is director. In its construction, not only the results of the Pacific R. R. Exploring Expeditions, and those of the Mexican Boundary Commission, but all the earlier investigations, which are reliable, including those of Lewis and

Clarke, 1804–6, Long, 1819–23, and many of a more recent date, have been collated and employed. Although much information is yet wanting in respect to the vast regions thus delineated, the map is an important embodiment of what has been ascertained.

CAPT. HUMPHREYS'S REPORT ON THE PROGRESS OF U. S. EXPLORATIONS AND SURVEYS.—The report of Capt. A. A. Humphreys, of the office of Explorations and Surveys, under the Secretary of War, presented to Congress at its recent session has been recently distributed. In addition to a statement of Lieut. Warren's operations, the following particulars are given.

1. The experiment of sinking artesian wells on the public lands has been prosecuted by Capt. Pope so far as to demonstrate that with any reasonable amount of expenditure, artesian wells on the Llano Estacado, and plains of similar formation and position, are impracticable. A well was sunk to the depth of a one thousand and fifty feet; beyond that depth it could not be carried. Apprehensions are even entertained as to whether the water would flow at the surface, if the boring were carried to the depth originally intended.

2. The field work of the exploration of the Rio Colorado of the West has been completed, and the report and maps are now in preparation. The river was ascended by steamboat to a point nearly 500 miles from its mouth (lat. 36° 06′), beyond which it was impracticable to proceed in boats. The ascent occupied about 70 days, but is said to be practicable in ten or twenty days by steamboats of suitable construction and two feet draft. The head of navigation is 220 miles from the first Mormon settlement in the Great Lake Basin, and 500 from the Great Salt Lake.

3. The explorations recommended for the next season are the examination of the interior of Nebraska, especially the sources of the Yellowstone; the region along the San Juan to its junction with the Rio Colorado of the West, and along the Spanish trail from that river to Abiqui; the route across the Sierra Nevada to Carson's river to ascertain its railroad practicability and the upper Columbia river to ascertain its navigability.

DIETERICI'S ESTIMATE OF THE POPULATION OF THE WORLD.—Prof. C. F. W. Dieterici, Director of the Statistical Bureau of Prussia, presented to the Berlin Academy of Sciences in March, 1858, an estimate of the population of the earth, which is printed in Petermann's Journal for January, 1859, together with two other articles from the same pen, giving corresponding estimates for the different races and religions. Dr. Petermann has accompanied the articles with a map of the world, exhibiting at a glance the comparative density of the population in different parts of the globe. The eminence of Dieterici as a statistician gives peculiar value to these estimates. We quote his results,

remarking that the data upon which they are based are given in the journal above referred to.

1. *Total Population of the Earth.*

	Square miles.*	Inhabitants.	Inhab. to sq. m.*
Europe,	182,571	272,000,000	1490
Asia,	793,964	755,000,000	951
Africa,	543,570	200,000,000	368
America,	750,055	59,000,000	79
Australia,	161,452	2,000,000	12
South Polar lands,	2,288		
In the world,	2,433,900	1,288,000,000	529

2. *Population of the Earth by Races.*

Caucasian,—	Europe,	270,000,000
	Asia,	36,000,000
	Africa,	4,000,000
	America,	58,000,000
	Australia,	1,000,000
		369,000,000
Mongolian,	Asia,	522,000,000
Ethiopian,	Africa,	196,000,000
American,	(The Indians,)	1,000,000
Malay,	Asia & Austr.	200,000,000
		1,288,000,000

Or, in round numbers, we may say that of 1,300,000,000 inhabitants of the globe, 375,000,000 are Caucasian, 528,000,000 Mongolian, 200,000,000 Malay, 196,000,000 African, and 1,000,000 American; or by percentage, 28·85 are Caucasian, 40·61 Mongolian, 15·38 Malay, 15·08 African, and 0·08 American.

3. *Population of the Earth by Religions.*

Christians,	335,000,000	or	25·77 per cent.
Jews,	5,000,000	or	·38 " "
Asiatic religions,	600,000,000	or	46·15 " "
Mahommedans,	160,000,000	or	12·31 " "
Heathen,	200,000,000	or	15·39 " "
	1,300,000,000		

The Christians include

Roman Catholics,	170,000,000	or	50·7 per cent.
Protestants,	89,000,000	or	26·6 "
Greeks,	76,000,000	or	22·7 "

FERNANDO DE COSTA LEAL'S REPORT OF THE EXPEDITION TO THE MOUTH OF THE RIVER CUNENE, SOUTHERN AFRICA.—The accounts already published of Dr. Livingstone's explora-

* These are German square miles, one of which equals sixteen English sq. miles.

tions in Southern Africa, and the earnestness with which this intrepid traveller has engaged in a new expedition, give a peculiar interest to all investigations in that part of the world. Among other inquiries which have long been unsettled, the extent and course of the River Cunene, or Nourse, emptying into the Atlantic Ocean, in lat. 17° 30′ S., now appears to be determined. Pimentel, Chapman, Owen, and others had given concerning it such contradictory accounts, that at one time it was supposed to be a large river furnishing the readiest access to Central Africa, and navigable for the largest ships, and at another it was doubtful whether it even extended to the ocean.

A Portugese expedition, in 1854, undertook to ascertain the truth, proceeding from Mossamedes, a colony on the west coast of Southern Africa, to the mouth of the Nourse, and then ascending the river a considerable distance. In Petermann's Journal (1858, p. 412) an account of this expedition and its results is given from the manuscript just received, of Fernando de Costa Leal. We translate the entire article. It is dated Mossamedes, Nov. 24, 1854, and is as follows.

For a considerable time past mention has frequently been made of the River Cunene, the fertility of its banks, and its mineral wealth; but these communications from the traders of the Desert contained nothing in reference to the mouth of the river, and hence it remained undetermined whether the river was navigable throughout its course.

The mouth of the river is on the west coast and not upon the east, as is erroneously represented on the chart to the 'Investigations of Lopez de Lima into the Statistics of our transmarine Possessions.'

According to the representation of the Bush traders respecting the course of the river, and the account of the Muimbas and Musimbas, tribes living upon the left shore of the Cunene, this river has its source in the land of Nano (which, in the language of the natives, means Highlands), constitutes the boundary between Molomba and Kamba, passes by Canhama, situated on its right bank, and then curves round to the coast, below 17° 51′ south latitude.

With a view of rendering a service to my country, I determined to proceed, in person, to the mouth of the river, in order to convince myself of what degree of importance it might prove to the interests of the commerce with Africa. I accordingly sailed from Mossamedes Bay in the schooner 'Conselho,' on the 3d of November, in company with Messrs. Bernardino da Castro, director of the colony, A. A. de Oliveiro Cavalho, Josè D. Franco, and Antonio R. Franco, who had expressed an earnest desire to accompany me. We sailed southward, and arrived at the northern point of the Great Fish bay on the 8th of Novem-

ber. This bay, 6½ miles in breadth, is bounded on the east by immense sandy plains, and on the west by a peninsula of sand; it affords most convenient shelter to ships of every size, and abounds in fish; great profits would be realized from fisheries here established.

The surrounding region presents no trace of vegetation, save a small plant of the genus *Cactus*, but fresh water can be obtained in the immediate vicinity, and upon the coast towards the south, an area of about 30 miles in extent is thickly strewn with trunks of trees, which have been carried, during the great freshets, from the banks of the Cunene to the ocean, and have been thrown by the waves upon the coast to the north of its mouth.

As we approached the head of the bay, it seemed as though a forest and a large sea lay before us, which gave to the country a charming appearance. This vanished in a few moments, for the mirage had converted the smallest bushes into forest trees, and what appeared to be a sea in which were mirrored the large trees and other lofty objects, proved to be only a sandy plain! We spent November 8th, 9th and 10th in the bay. Our object originally was to proceed to the mouth of the river by sea, but since the exact situation of that point was but little known, and it had been reported that we should find the entrance difficult, as well as be unable to come to a secure anchorage, we determined to prosecute the remainder of the journey on land along the coast.

After the necessary preparations had been made, the entire company, consisting of ten whites and eleven negroes, disembarked, and we proceeded on our journey on foot. The shifting sand and the hot sun made our advance slow and tedious; at 5 o'clock P. M. we pitched our tent on the borders of Esponjas (the swamps). On the morning of the 12th we continued our march southwards, advancing over huge beds of granite, which were intersected by basaltic dikes; on our right were still seen the dunes of sand. Our progress was now rendered more easy, and after having advanced twelve miles, we halted for the night near the coast, although not the smallest trace indicated the proximity of the river. A small supply of water remained, with no expectation of our being able to obtain any in the immediate vicinity. Two persons were sent to some distance into the interior, and directed to dig pits for the purpose of obtaining water, but their efforts were fruitless. In no wise disheartened, firmly resolved to overcome all the difficulties of our march, a few other persons set out with the same object in view. In the evening, at half past 9 o'clock, they returned from their successful expedition, bringing two vessels full of clear and fresh water which they had taken from the river only 4½ miles distant from us.

Filled with joy and anxiously awaiting the break of day, we spent the night, and at 4 o'clock in the morning we struck our tent; at 5½ o'clock we reached the right bank of the Cunene, about 1½ leagues from its mouth. We followed the course of the river from this point to its mouth. Here we found that the mouth is completely closed up by a sand bank, which is overflowed only at times of high tide; at other times the water is lost in the sand. Pimental, in his Descriptions makes the remark, that the current of the river can be traced in the ocean for several miles; he also designates the course to be pursued with a boat on attempting the entrance into the river. I am convinced that this navigator passed at the time of high tide, and regarded this as the usual depth of the stream, hence he failed to remark this circumstance. Had we prosecuted the rest of our journey by sea, we would in all probability have determined very little in reference to the river, from the fact that the sand-bank is very high, and completely connected with the banks of the river at its mouth. This would certainly have been the result unless the latitude of the river had been previously determined with accuracy. Even if we had succeeded in discovering the river, the sea, very rough at this point, would have exposed the boat to great peril.

Near the coast, upon the right bank of the river, vegetation is quite abundant, and we met there with great numbers of deer, antelopes and goats. The sea coast takes a south-southeasterly direction, and affords not the least protection. The stream near the sand-bank is very shallow, too much so even to carry a flat-bottomed boat. The banks are but slightly elevated, formed of sand and pebbles, and covered with some vegetation. On our return to the camp, an elephant presented himself to our view, on the opposite bank, and in spite of the perils from the crocodiles swarming the river, to which our hunters were exposed, they crossed in safety and speedily drove the elephant into the interior.

On the 14th of November we followed up the course of the river on its right bank, observing on both sides of the river large piles of wood and thick trunks of trees similar to those seen upon the sea coast. The banks gradually rose to greater height, the stream grew narrower, but thus far no obstructions in the bed of the river were met with; after a two *hours* march we fell in with high waterfalls. Sand dunes constituting the left bank, and perpendicular masses of granite rock the right bank, compelled us to leave the shore and we only returned to it after a march of 4½ hours. The deep winding valleys which intersected the surface in this region, rendered this portion of our march much more wearisome than the earlier portion of it. Finding it impossible to advance any farther on this day, we re-

turned to the river in order to halt for the night on its banks. We found here an agreeable and picturesque spot, vegetation rather rich, consisting mostly of cedar trees, of a size far inferior to the European cedar. The banks here were less elevated, and afford an easy passage, although large rocks abound in the river; and upon the left bank sand-dunes are still seen. At this point we met with many traces of the elephant, zebra, the deer, the fox, the monkey, and the lion. The direction of the stream is N. ¼ West.

We resumed the march on the following day, with no expectation of replenishing an almost exhausted stock of provisions. We halted at 9½ in the morning, and after disposing of the remainder of our provisions, were on the point of turning back, when very luckily one of our soldiers killed a young elephant that accompanied by its dam had ventured within range of our guns. Soon after we resumed our march. The general appearance of the region through which we were advancing was the same, with this exception, that the vegetation seemed to be more fully developed, and the traces of the various animals, especially the elephant, became more numerous. This led us to believe that farther in the interior, great herds of elephants frequent the banks of the Cunene, which at certain seasons of the year, advance towards the mouth of the river. From the source of the stream to the point which we were able to attain, a distance of about 21 miles, we fell in with eight elephants, which all withdrew into the interior.

Up to this point the Cunene presents no points of any importance; its course is winding, the bed of the river narrow and obstructed by waterfalls, and hence not navigable. For even if these were to be removed, (which is not impossible,) yet the mouth of the river could not be cleared; for the current of the river, removing the sand-dunes on the left bank constantly deposits them near the mouth where the water is shallow and the current not so strong. Whether the Cunene be navigable at any point, we are as little able to say, as at how great a distance the tribes living on its banks kept themselves from us.

We discovered a mountain range of considerable height, running in a direction from north to south; but it was impossible for us to cross this range, since we were in no respect furnished with the necessary means. Our mission being quite a different one and already accomplished, we commenced our journey homeward on the 16th of November, and arrived at the Great Fish Bay on the following morning at 10 o'clock. The extent of our whole journey on foot being about 30 miles.

The result of the expedition is already apparent. Many of the inhabitants of Mossamedes, engaged in the trade of the desert, are preparing themselves for an excursion by land to the

banks of the Cunene. If a friendly intercourse with the people of this region be kept up, the colony will here find a new source of trade and wealth. This would result in leading that nation to carry on a direct trade with Mossamedes, after the example of the people of Gamba, Huilla, Jau, Humputa, Quillengues, Humbe, Kamba, Mulonde, and other places. D. C. G.

Yale College Library, April, 1859.

ART. XLII.—*On a new Sulphid of Copper and Lead;* by FREDERICK FIELD.

IN the 'Mina Grande' near Coquimbo, Chili, there exists a mineral containing sulphur, lead and copper, in certain proportions which render it highly interesting. From the same mine have been obtained the following ores of lead: vanadiate of lead, vanadiate of lead and copper, arseno-phosphate of lead, sulphate of copper and lead, and carbonate and sulphid of lead, besides an intimate mixture of sulphid and sulphate of lead, the former mineral evidently undergoing gradual oxydation.

The double sulphid of copper and lead has the following properties. Sp. gr. 6·10. H. from 2·5 to 3. Massive. When broken, a slight conchoidal fracture, having a deep indigo-blue color, quickly tarnishing on exposure to the atmosphere. Immediately associated with carbonate of lead and carbonate of copper.

The pure mineral is violently acted upon by nitric acid, with the formation of sulphate of lead and liberation of free sulphur. 100 parts yielded—

Copper,	53·63
Lead,	28·25
Sulphur,	17·00
	98·88

corresponding to $3Cu_2S$, PbS, which requires Cu 53·33, Pb 28·88, S 17·77.

The only other simple combination of sulphid of copper and lead with which I am acquainted is the cupro-plumbite of Plattner, (also from Chili,) which is a compound of Cu_2S, 2PbS.

I have proposed the name *Alisonite* for this mineral, in honor of R. E. Alison, who has spent many years in developing the mineral wealth of Chili.

Guayacan, Coquimbo, Jan. 29, 1859.

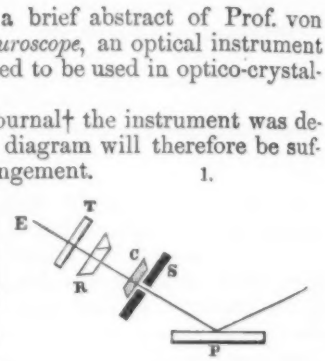
APPENDIX.—In a letter to one of the editors of the same date, Mr. Field observes, that the mineral described by him under the name of *Guayacanite* (this volume, p. 52), he has found to be the rare species Enargite.

ART. XLIII.—*An Abstract of Prof. von Kobell's Stauroscopic Observations;* by OGDEN N. ROOD, Professor of Chemistry in Troy University.

THE following pages contain a brief abstract of Prof. von Kobell's observations with the *stauroscope*, an optical instrument lately invented by him and designed to be used in optico-crystallographical researches.*

In a previous number of this Journal† the instrument was described and figured; the annexed diagram will therefore be sufficient to point out its optical arrangement.

1.



P is a plate of glass which reflects polarized light toward the eye at E, S is the stage-plate or engraved square, C the crystal under investigation, R a plate of calc spar cut at right angles to its optic axis, and T is the analyzing tourmaline. During the experiments the stage-plate S with the crystal is revolved about the axis EP, the rest remains stationary.

I have found it much better to use two Nicol's prisms instead of the glass plate and the tourmaline, and in my own experiments at the end of this article they were employed exclusively.

The plate of calc spar being in its proper position, the tourmaline is turned so as to darken the field, and upon looking through the instrument the usual black cross is seen, of which we shall afterwards speak, surrounded with its concentric colored rings. The dark field which would be seen without the plate of calc spar is more sharply defined by the cross.

When the third cylinder is put in, its slider fitted to the second, and the divided circle turned around to zero, then two sides of the engraved square coincide in position with the axis of the tourmaline. If it be wished to determine the directions (or planes) in which the polarized rays of a double refracting crystal vibrate with regard to the edges of the observed crystal plane, the crystal is to be fastened with wax on the engraved plate over its opening, and turned till one of its sides is parallel with one of the sides of the engraved square, the cylinder with the crystal is then slid in, and the graduated circle turned to 0.

* See von Kobell's "Mineralogie," 2nd edit. 1858, p. 47.
† Vol. xix, 2nd Series, p. 425, and xx, 415.

If the cross is seen unchanged in its position then the polarized rays of the crystal vibrate in the direction of the side of its plane and at right angles to it, but if no cross should appear, or if it should be changed in its position, it is a proof that the rays do not vibrate in the direction of the edge of the crystal plane under observation, and it is necessary to turn the cylinder to which the crystal is attached a certain fixed number of degrees till this happens and the cross again appears in its upright normal position; the angle is read off by means of the vernier. In this manner it is possible to obtain through the stauroscope certain characteristic optical distinctions for the different crystalline systems, by which they often may be determined when other means fail.

I. *System of simply refracting crystals.*

MONOMETRIC SYSTEM.

Monometric crystals show, in every position in which they can be put on the stage, the cross normal; however the stage may be turned it remains unchanged.

Examples: Rock salt, alum, spinel, fluor. Amorphous pieces behave in the same manner.

II. *Systems of doubly refracting crystals.*

All doubly refracting crystals show in certain directions the cross *inclined*, or by revolving them they *extinguish* the normal cross; it is only in the directions of their optic axes that they behave to a certain extent like monometric crystals.

Systems with one optic axis.

1. DIMETRIC SYSTEM.

(1.) Seen through a plane of the quadratic pyramid the cross arranges itself according to the verticals of the triangle or at right angles to each of its sides.

(2.) Through the prismatic faces the cross has the position of the principal axis.

(3.) Through the basal plane the cross appears normal and remains unchanged when the crystal is revolved.

Examples: Apophyllite, idocrase, zircon, scapolite.

2. HEXAGONAL SYSTEM.

(1.) Through a plane of the hexagonal pyramid the cross stands in the directions of the verticals of the triangle or at right angles to each of its sides.

(2.) Through the sides of the rhombohedron the cross arranges itself in the directions of the diagonals.

(3.) Through the faces of the scalenohedron the cross arranges itself according to the lines of altitude of the sides of its holohedral dihexagonal pyramid, or at right angles to the sides of its horizontal twelve-sided transverse section.

(4.) Through all the prismatic sides the cross is seen normal in the direction of the principal axis.

(5.) Through the basal plane the cross is seen normal and unchanged by the revolution of the crystal.

Examples: Apatite, quartz, calcite, chabazite, emerald.

Systems with two optic axes.

In these systems there occur no planes through which the normal cross remains unchanged during the revolution of the crystal.

3. TRIMETRIC SYSTEM.

(1.) Seen through a plane of the rhombic pyramid the cross makes *three* angles with the three sides, corresponding to the inequality of the sides of the triangle.

(2.) Through the prismatic faces and also through the macro- and brachy-diagonal planes the cross is in the direction of the principal axis, also through the domes it is in the direction of the dome edge.

(3.) Through the basal plane when it is rhombic the cross stands in the direction of the *diagonals*, when it is rectangular in the direction of its sides.

By revolving the crystal the cross becomes pale or is altered by colors.

Examples: Heavy spar, topaz, sulphate of magnesia, aragonite, chrysolite.

4. CLINO-RHOMBIC OR MONOCLINIC SYSTEM.

(1.) Through the lateral planes of the oblique rhombic prism the cross is inclined to the principal axis; also through the planes of the clinodome it is inclined to the dome-edge. The angle through which it is necessary to turn is the same for like planes, and the crosses are turned towards or away from the clinodiagonal chief section to the right or left with equal angles, when seen respectively through the back or front sides of the crystal.

(2.) Through the orthodiagonal plane the cross is normal in the direction of the principal axis.

(3.) Through the clinodiagonal plane the cross is inclined to the principal axis.

(4.) Through the basal plane of the rhombic prism the cross stands according to the diagonals.

Examples: Diopside, selenite, orthoclase, epidote, borax.

5. TRICLINIC SYSTEM.

The cross appears through every plane inclined at a certain angle, when any one of the planes or corresponding edges of the crystal is placed horizontal or vertical on the engraved stage.

Examples: Kyanite, albite, sulphate of copper.

ART. XLIV.—*Stauroscopic and other Optical Experiments;* by Prof. OGDEN N. ROOD.—Part I.

1. *Stauroscopic Observations on Cooled Glasses.*

IN the Stauroscopic observations of Prof. von Kobell plates of crystals with natural or artificial parallel sides were employed, and it is of course a matter of indifference through which part of the plate the polarized beam is transmitted, the phenomena observed being the same whether the centre or any of the edges be employed. The case is however different with plates of glass of a definite shape to which double refraction has been communicated by sudden cooling from a red heat or otherwise.

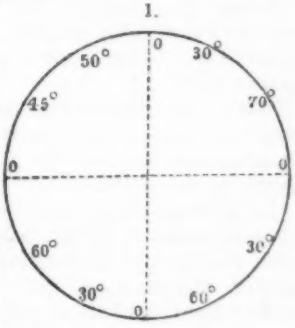
Having arranged a stauroscope with an open stage I submitted to examination pieces of glass of different figures to which double refraction had been thus communicated; the following are some of the *simpler* results obtained.

1. Through the centre of the equilateral triangle the cross arranges itself in three positions, at right angles to its three sides; the cross is of course not stationary when the triangular plate is revolved. The same is true when the polarized beam is transmitted through three spaces near the middle of its sides.

Through the angles of the triangle the cross is *inclined* to the above mentioned planes.

I found no spot in the triangle where the cross remained unaltered when the glass plate was revolved.

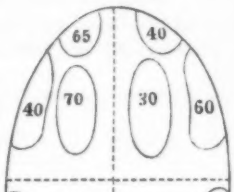
2. Through the centre of a circular plate of glass the cross remained tolerably unaltered by revolution, this position of the plate corresponds therefore to the basal plane of a crystal belonging to the dimetric system.



Through the spaces 0, 0, 0, 0, the crosses are altered by revolution and arrange themselves in the positions of the dotted lines. Seen through the spaces marked with figures the crosses arranged themselves at these angles to the dotted lines.

3. Through the centre of an elliptically shaped plate the cross was altered by revolution and arranged itself in the directions of the major and minor axes. The same is true for the spaces along the dotted lines.

2.



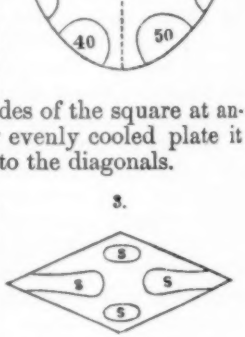
The inclinations of the crosses to the axes of the ellipse in different portions of the plate will at once be seen by the annexed diagram, and also that the arrangement of the outer portions is essentially the same as in the circle, the main difference being in the occurrence of the oval-shaped spaces on either side of the foci.

4. Through the centre of the *square* the cross remains tolerably unchanged by revolution; near the middle of its sides the cross is altered by revolution and arranges itself at right angles to the sides.

In the angles it was inclined to the sides of the square at angles of from 30° to 50°. In a perfectly evenly cooled plate it would probably arrange itself according to the diagonals.

5. Through the centre of a rhombic-shaped plate the cross arranged itself parallel to *only* two sides of the rhomb; it remained always somewhat colored. (See under circular polarized light.) Through the spaces s, s, s, s, it arranged itself according to the diagonals.

3.

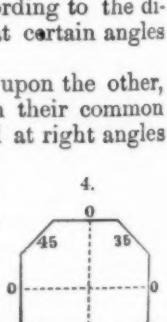


6. Through the centre of a rectangle, whose length was four times its breadth, the cross arranges itself according to the diameters: in the angles the crosses are *inclined* at certain angles to the diameters.

When two pieces of this shape are laid one upon the other, parallel or at right angles, and viewed through their common centre, the cross still arranges itself parallel and at right angles to their sides.

When the plates were inclined 45° to each other no black cross was seen in any position; in its place a red or green nebulous cross appeared at all inclinations. (See below.)

4.



7. Through the centre of an octagonal shaped plate the cross remained tolerably unaltered by revolution; in the spots marked 0 the cross was altered and arranged itself accordingly to the dotted lines; in the spaces marked with numbers the crosses made these angles with the dotted lines.

From these observations it will be seen that the crosses remain unaltered when viewed through the centres of regular polygons, as for example, the square, the octagon, and the circle, the latter being considered a regular polygon with an infinite number of sides; the *centres* of such polygons are therefore uniaxial and correspond to the basal plane of uniaxial crystals: the positions of these solids which I have marked 0 correspond with the *prismatic faces* of uniaxial crystals; the portions marked with numbers correspond in a certain sense with the planes of the quadratic pyramid. It is remarkable that we should have in portions of one plate a representation of the action of all the planes of a *crystal*.

The central portions of the ellipse and rectangle correspond to the basal plane of a crystal belonging to the rhombic system; the rhombic plate of glass had not been cooled with sufficient regularity to base a conclusion on its action though indications were observed which would place it along with the ellipse—at all events the spots marked *s* acted like the rhombic shaped basal plane of a rhombic prism.

The centre of the triangle corresponds in action to a plane of the quadratic pyramid.

2. *Observations on Circular Polarization by means of Cooled Glasses.*

(1.) The celebrated physicist, Dove, found when a *cube* of glass was suddenly cooled and afterwards placed in a polarizing apparatus and inclined 45° to the plane of primitive polarization, that the plane polarized beam was converted into circular polarized light by transmission through the corners of the square plate; this he proposed as an easy method of producing circularly polarized light.

I have found that when a beam of polarized light is transmitted through the centre of a *rhombic* shaped plate of glass (see above) which had been thus treated that the light was more or less circularly polarized *whatever the position* of the rhomb with regard to the plane of primitive polarization might be, though the experiment succeeded more strikingly when its position corresponds to that of Dove's cube. The polarization was right-handed, and the colors were as brilliant and followed each other with as much regularity as when seen through a quartz plate cut expressly for this purpose.

(2.) Through the centre and portions along the major diameter of an elliptically shaped piece of glass the light is also circularly polarized when either of the axes are inclined at angles of 45°, 135°, &c., to the plane of primitive polarization. The polarization was right-handed, and in both these cases a *large beam of circular polarized light* was obtained; by changing the angle of the

plate with the plane of primitive polarization I easily obtained elliptically polarized light, the axes of the ellipse having any desired relation to each other.

(3.) Through the centres and along the chief diameters of rectangular shaped pieces of glass, whose length was four times their breadth, the light was also circularly polarized when the inclination was 45° to the plane of primitive polarization. When two rectangles were crossed at an angle of 45° and placed as above, the light was more completely circularly polarized, it was found to be *right-handed;* upon reversing the inclination of the rectangles to each other the beam was turned to the *left hand.*

It will be seen therefore that by means of two similar rectangles of cooled glass, either right or left-handed circular polarization may be obtained at pleasure, an observation I believe which has never before been made.

(4.) The light in all the angles of the octagon was circularly polarized.

3. *On the appearance presented by circularly polarizing crystals, &c. in the Stauroscope. The cross a means of detecting circular or elliptical polarization.*

If a plate of quartz be cut at right angles to its axis and of such thickness that for example it gives the yellow tint when placed in the field of a polariscope, then when introduced into the stauroscope it will modify in a certain manner the cross and the colored rings.

(1.) No *black* cross will be seen in any position of the quartz plate; in its place a *yellow* cross appears which remains stationary and in its normal position when the quartz is revolved, and the white quadrants next to the calc spar cross are replaced with patches of red and blue color.

(2.) When the analyzing plate is revolved the yellow cross *revolves with it*, passing at the same time through all the prismatic tints, the rings not being greatly changed. If the plate is thicker or thinner than the above mentioned, the initial cross will merely in the first instance be differently tinted, but the color will in every case be the same with that which the whole plate would have if placed in the darkened field of a polariscope; the rest of the phenomenon remains the same. The circular polarized light obtained through cooled glass acted in exactly the same manner.

I have found this colored cross, stationary and revolving, an excellent means of detecting circular polarized light when it would otherwise have been overlooked, that is, when such a brilliantly colored cross is seen which revolves with the analyzer through the whole circle, changing always in tint but never becoming black, it is a proof that the light is *circularly* polarized.

When the polarization is elliptical a colored cross it is true will be seen and it will revolve with the analyzer and change in tint, but at angles of 180° it becomes normal and nearly black.

Of course light occurs in every state of polarization, passing from elliptical through circular to plane, according to the relative dimensions of the axes of the ellipse, but after some practice it is possible by means of the cross to judge of these dimensions approximately.

In examining this matter, besides using plates of quartz, &c., I constructed an apparatus for producing plane, circular, or elliptical polarization by means of the inclinations to the plane of primitive polarization given to a lamina of mica of a certain thickness, the state of polarization of the light from the mica was examined with a doubly refracting rhomb of calc spar before observing the cross.

Troy University, Dec. 25th, 1858.

ART. XLV.—*On Boltonite;* by Prof. GEO. J. BRUSH.

THE identity of this mineral with chrysolite was pointed out by Professor J. Lawrence Smith in this Journal, vol. xviii, p. 372 (November, 1854). Previously to this Dr. Kenngott* endeavored to show from analyses made by v. Hauer that boltonite was a distinct species. Subsequently† Kenngott calls in question Smith's conclusions: from v. Hauer's analyses he draws the formula $\dot{R}^5\ddot{S}i^2$, and insists that this, together with the low hardness (5·5) of the mineral, shows that boltonite is not chrysolite. In Dr. Smith's examination, the mineral was as carefully selected from the gangue as possible and then freed from adhering carbonates by repeated treatment with dilute hydrochloric acid; afterwards great care was taken in choosing for analysis the purest of the fragments thus treated. Three analyses made upon specimens so selected gave:

	$\ddot{S}i$	$\dot{M}g$	$\dot{F}e$	$\ddot{A}l$	Ignition.
1.	42·56	51·77	2·35	0·10	2·22 = 99·00
2.	41·95	51·64	3·20	0·25	1·58 = 98·62
3.	42·41	50·06	3·59		not. det. ——

which excepting the slight amount of loss by heat (not necessarily water) indicate a perfect correspondence with chrysolite.

Von Hauer did not find it practicable to separate the boltonite from the gangue, but analyzed a specimen with the accompanying gangue. In his first analysis the mineral was decomposed by fusion with carbonate of soda. His results gave—

* Mineralogische Notizen, Zwölfte Folge (March, 1854).

† Uebersicht der Resultate mineralogischer Forschungen im Jahre, 1854. Leipzig, 1856.

	$\dot{S}i$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\bar{C}$
No. 1.	13·32	3·80	29·00	21·17	32·71

The carbonic acid (32·71 per cent) was determined by the loss.

In the second analysis, made upon the same mixture, the mineral was treated with dilute hydrochloric acid, and the bases in the acid solution were determined and *calculated* as carbonates. The insoluble portion was decomposed by fusion with carbonate of soda. The magnesia in both the soluble and insoluble portions were determined *by the loss*. Analysis No. 2 gave—

$\dot{F}e\bar{C}$	3·37	72·70 soluble in H Cl.
$\dot{C}a\bar{C}$*	50·93	
$\dot{M}g\bar{C}$	18·40	
$\dot{S}i$	12·85	27·30 insoluble in HCl.
$\dot{F}e$	1·74	
$\dot{C}a$	0·94	
$\dot{M}g$	11·77	

Assuming the carbonic acid (which was determined by the loss) in No. 1 to be combined with the bases in the same manner as found in No. 2, Kenngott shows that No. 1 contained 28·64 per cent insoluble in acid. The percentages of the substances in the insoluble portions in both analyses would then be:

	$\dot{S}i$	$\dot{M}g$	$\dot{F}e$	$\dot{C}a$
1.(*a*)	46·50	43·89	6·08	3·53
2.(*a*)	47·07	43·11	6·38	3·44

Kenngott calls attention to the close correspondence between the analyses and insists that the method employed by v. Hauer to obtain the true composition of boltonite is quite as satisfactory as that adopted by Smith.

It is however worthy of remark, that the carbonic acid in both of v. Hauer's analyses was determined by the loss, that the magnesia in both soluble and insoluble portions in No. 2 was also determined by the loss, and that the errors have been increased more than threefold by the manner in which the analyses were calculated. It may well be questioned whether conclusions based upon analyses made in such an indirect manner should be permitted to throw doubts on analyses of carefully selected material where everything was determined directly.

The fundamental point in the conclusions which Kenngott draws from v. Hauer's analyses depends upon the assumption† that boltonite is not attacked by dilute hydrochloric acid, for in

* In the analysis the $\dot{M}g\bar{C}$ is stated to be 50·93 and $\dot{C}a\bar{C}$ 18·40, but the remarks that follow show that this inversion is a typographical error.

† To avoid misrepresentation on this important point I quote from the original article, p. 27 of the 12th No. of Kenngott's *Mineralogische Notizen*: "Da aus der Analyse hervorgeht, dass das Grundgestein kein reiner Calcit ist, auch der Einfluss der Luft auf das Grundgestein zeigt, dass es Eisenoxydul enthält, so wurde eine zweite Probe desselben Gemenges mit sehr verdünnter Salzsäure digerirt, wobei das Silicat, der Boltonit, gewiss nicht angegriffen werden konnte."

No. 2 the portion insoluble in dilute hydrochloric acid was considered to be pure boltonite, and from this was calculated the composition of boltonite as given in 1 (*a*) and 2 (*a*).

But I have found by experiment that boltonite is acted* upon even by very dilute hydrochloric acid, and this being the case, the insoluble portion in v. Hauer's analysis must have contained an excess of silica derived from the partial decomposition of boltonite by dilute acid. It is therefore evident that any conclusions in regard to the composition of boltonite based upon the analysis of this insoluble portion must be erroneous. This partial decomposition of boltonite also affords a satisfactory explanation of the excess of silica in v. Hauer's analysis over that obtained by Smith.

It is unnecessary to follow Kenngott farther, as I shall proceed to show from my own analyses the correctness of Smith's conclusions.

In the year 1854 I made an examination of boltonite, but not being entirely satisfied with the purity of the substance analyzed, the analysis was not published. The mineral was separated from the gangue by acetic acid and selected as carefully as possible. Fused with carbonate of soda it gave—

Si	Mg	Fe	Ca	Al	Ignition.
40·94	50·54	4·37	1·20	0·27	3·28 = 100·60

Disregarding the ignition, the result confirmed Dr. Smith's analyses, but I could not be certain that the mineral was perfectly pure, and it was not until a few weeks since that Prof. C. U. Shepard kindly placed at my disposal a specimen containing large irregular crystals of boltonite from which I have been able to select the mineral pure for analysis.

It occurs in a magnesian limestone in crystals which are sometimes more than an inch in diameter; these irregular crystals implanted in the gangue often present rectangular sections, and have a very distinct cleavage in one direction. The color of the specimens I examined was dark ash-grey, but small fragments were almost colorless. It scratches feldspar, and therefore the hardness is 6 or a little above. Its specific gravity is 3·21. Before the blowpipe in platinum forceps it does not fuse but the color changes to light-yellow; with salt of phosphorns gives reactions for silica and iron. When treated with very dilute hydrocloric acid (i. e., one part acid to ten parts water) the powdered mineral is partially decomposed. In the quantitative analysis the mineral was first powerfully heated over a blast lamp and subsequently decomposed by carbonate of soda. The analysis gave—

* Dr. Smith also alludes to this fact *loc. cit.*

		Oxygen.		Ratio.
Silica,	42·82	22·25	22·25	1
Magnesia,	54·44	21·77		
Protoxyd of iron,	1·47	·33	22·34	1
Alumina,	*trace.*	——		
Lime,	0·85	·24		
Ignition,	0·76			
	100·34			

This ratio gives the formula of chrysolite $\dot{R}^3\ddot{S}i$. The analysis fully confirms Dr. Smith's conclusions, and shows that boltonite is a *magnesian* chrysolite, that is, unlike other varieties of the species, it is a silicate of magnesia and not of magnesia and iron.

Yale Analytical Labratory, Dec. 1st, 1858.

ART. XLVI.—*Varying Level of Lake Ontario;* by Prof. C. DEWEY.

IN vol. xxxiii of this Journal I gave the varying temperature of Lake Ontario in 1837, and confirmed the result by observations in vol. xxxvii. The variations in the level of this lake, as well as of the other great lakes of this chain of waters, has been the subject of much observation and of many singular, if not absurd, traditions and speculations. The want of measures, known to be reliable, has been a great support of these fancies. In the following Table the remedy is in part attained. The measures were made at the Port of Genesee, Charlotte, at the mouth of Genesee River, by order of the Government. They have been reported annually in the local papers, and in the Regents' Report, and I now present the measures and results obtained for the thirteen past years.

Variations of the Level of Lake Ontario, for the enumerated years, measured from a fixed point downwards to the water.—The *larger* the measure, the *lower* the level.

TABLE.—Measure in inches.

Years.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep	Oct.	Nov.	Dec.	Mean	Range	Relative.
1846	51	54	48	45	42	39	39	42	45	45	48	45	45·2	15	Low.
1847	48	42	36	36	29	25	25	25	36	39	43	46	35·8	23	Bel'w mean.
1848	29	34	43	38	38	37	38	39	44	49	54	53	41·3	25	" "
1849	50	50	52	46	36	33	44	39	45	38	38	41	42·7	19	" "
1850	45	40	40	40	32	29	34	46	47	52	55	43	41·9	26	" "
1851	44	54	48	47	44	38	35	38	42	47	53	51	45·0	19	Low.
1852	50	51	48	44	26	26	22	24	30	23	38	34	34·7	29	Higher.
1853	35	32	32	25	20	14	27	20	24	28	38	39	27·8	25	High.
1854	39	39	38	38	27	24	25	27	36	44	48	50	36·2	26	Bel'w mean.
1855	52	53	36	40	40	36	34	36	36	34	33	33	38·6	20	" "
1856	35	35	33	31	23	18	23	30	37	46	53	53	34·7	35	Higher.
1857	54	56	46	44	35	24	19	12	14	9	24	22	30·0	47	High.
1858	19	13	13	18	4	6	4	2	8	12	14	16	10·9	17	Very high.
Means.	42	42	39	38	30	27	28	29	34	36	41	40	29·8	25	

Some results are obvious on the Table.

1. The summer months have higher water, for 10 of the 13 years. As this depends on the melted snows and spring rains over the greater watershed, the water is higher in the eastern of the lakes later in the season, affecting Lake Ontario after Lake Erie.

2. The winter months have the lower water for ten of the thirteen years. This is owing to the less water which falls over the section in the fall months and the greater evaporation through the preceding months.

The means of the months at the bottom of the table illustrate the general conclusion involved in these two results.

3. In 1848 the level was the lowest in November; in 1850 in November, and in 1856 equally low in November and December, from the less rains in the preceding months.

4. In 1848 the highest was in January; and in 1857 in October; and in 1855 in November, from preceding rains.

5. The lowest measured in these years was in February, 1857, and the highest in August, 1858, giving the range in the whole period to be 56−2=54 inches. [The maximum and minimum level was at Toronto in the same two months of these two years, and the range was the same, 54 inches. For this fact I am indebted to the intelligent and accurate observer at that port in Canada West, the Harbor Master. The range is found to be nearly the same in Lake Michigan.] These facts show that the common statements, in the summer of 1858, of the lake being some feet higher than before known or in many years, were utterly false. In 1858 the level was seven inches higher than in 1857.

6. There is no periodical rise and fall of the lake discernible on the table, and the variations in the level of the lake seem to be dependent on very regular and adequate causes of supply and drain.

7. Observation shows that the direction and force of the winds make the variations not altogether simultaneous at the ports having positions differently affected by the winds. Still a series of observations must lead to closely approximate results.

8. The table contains only the slow monthly and annual changes of the level. I have not introduced other measures, made in some other parts of this lake, on account of the impossibility of reducing them to the same zero, as there has been no standard, but different points have been assumed by observers. Neither have I noticed those sudden changes of the level, where the water falls or rises several feet in a few moments; and when the return wave causes the water to rise or fall alternately three to six feet. These alternations occur several times about twelve or fifteen minutes apart till the water comes to the previous level. Some of these are known to have been caused by violent winds or whirlwind tempests. Probably this is the uniform cause, as it is fully adequate to the effect.

Rochester, N. Y., March, 1859.

ART. XLVII.—*Contributions to Mineralogy;* by F. A. GENTH.

1. *Whitneyite, a new species.*

MASSIVE, structure crystalline, finely granular. H. = 3·5. Sp. gr. at 16° Cels. = 8·408. Lustre metallic; color reddish-white (about that of the new American cent, or of an alloy of equal quantities of copper and silver). Admits of a fine polish, but soon tarnishes, first assuming a yellowish hue, which gradually changes to brown and finally to brownish-black; sometimes iridescent. Somewhat malleable.

B.B. it fuses readily and gives off the odor of arsenic. Insoluble in chlorhydric acid; soluble in nitric acid. Composition: $Cu_{18}As$. Analyses:

			Calculated.
Copper,	88·07	88·19	88·37
Arsenic,	11·81	11·41	11·63
Silver,) Insoluble,)	0·33	0·47	
	100·21	100·07	100·00

The material for the analyses was selected with the greatest care and was apparently quite pure.

It occurs coated with red copper, and a copper-salt resulting from its oxydation, probably olivenite. One boulder of forty pounds in weight has been found at the Pewabic Mine, Houghton County, Mich., and was mistaken for silver. The material for the above analyses has been kindly presented to me by John F. Blandy, Esq., of Philadelphia. According to the information received from him, the agent of the Albion Mine recognizes the same mineral as occurring in a small vein of from three to four inches in width, and about one mile from the Cliff Mine, at the Albion location. I have named the mineral in honor of Professor J. D. Whitney, who informs me that a mineral, which he found at the Minnesota Mine, is identical with my new species.

In its chemical relations it is of considerable interest, because it is another example in which a multiple of six equivalents of copper combines with one of arsenic, forming with domeykite and algodonite a beautiful series of arsenids of copper, viz:

Domeykite,	Cu_6As.
Algodonite,	$Cu_{12}As$.
Whitneyite,	$Cu_{18}As$.

(*To be continued.*)

Art. XLVIII.—*On Spontaneous Generation.*

1. *Remarks of Prof.* Milne Edwards *on the value of certain facts as evidence of the spontaneous generation of animals,* made before the Academy of Sciences at Paris,* at the session of January 3, 1859.

Physiologists have long been divided on the subject of the origin of life in organized beings. The larger part believe that this force exists only where it has been transmitted; that from the creation of the species till the present time, an uninterrupted chain of possessors of this power has communicated it successively; and that dead matter has no power of organizing a plant or an animal unless it be submitted to the action of a living being or a germ that has proceeded from an individual of some species.

Others, on the contrary, have held that inert matter, under certain chemical and physical conditions, could take on life without the agency of a generating being; that plants and animals may produce themselves in all their parts without deriving the principle of existence from another living body; and that consequently life itself must be considered, not as a force which has been imparted peculiarly to organized beings, but as a general property of organizable matter manifesting itself under certain favorable conditions.

In my lectures and writings, I have often combatted this last doctrine; and the hypothesis of *spontaneous generation* has to-day so few supporters among zoologists, that I should have feared to abuse the patience of the Academy in discussing it at this time, had I not seen in the Report of a recent session of this body, that one of our correspondents, Mr. Pouchet, had made it the object of new researches and had arrived at conclusions, which, if right, sustain the idea that living beings may be made by the same general forces on which chemical combinations in inorganic nature depend. Since reading this memoir, I have thought it might be useful to submit to the judgment of my colleagues my reasons for rejecting its conclusions; and it appears to me desirable also to know the opinions of other physiologists on a point of so much importance: besides, the question reaches beyond the domain of the natural sciences, and we may look for additional light from our chemists.

Long before the invention of the microscope had enabled zoologists to discover the animalcules which are produced in

* Comptes Rendus, 1859, p. 23. The Zoologists and other members of the Academy who have here expressed their views on spontaneous generation, are at the head of their respective sciences in France.

myriads in waters containing an infusion of organic matters, it had been observed that dead bodies when left to putrefy often became populated with swarms of life; and as the intervention of no living being was manifest in their production, the old naturalists supposed them a product of the putrefaction which was in progress, believing that the material, after ceasing to pertain to a living being, could reorganize itself under a new form and so constitute animals which had no parent; accordingly, that life is not the cause, but the consequence of a certain mode of arrangement of the molecules composing these substances, and that this kind of molecular grouping could be determined by inorganic forces in nature.

The occurrence of maggots in carrion was one of the cases. But since the study of the origin of these animals by the Florentine Academy, happily named "del Cimento," and the exact investigations of Redi, one of its members, it has been well understood that these worms about dead bodies, far from being a result of spontaneous generation, are the brood of well known insects, species which find in such bodies the conditions requisite for development, and hence, through a marvellous instinct, deposit there their eggs.

The experiments of Redi, which date from the middle of the 17th century, left no uncertainty respecting these larves. But while very easy to establish the fact respecting animals as large as flies, it was far less so with regard to infusory animalcules, which are discernible only by means of the microscope, and whose germs are so excessively minute that they have escaped all the methods of observation which the science of optics has supplied. When, therefore, Lewenhoek and his successors made known the existence of these animalcules, the hypothesis of spontaneous generation regained favor. While some physiologists regarded them as derived from germs of extreme minuteness which were spread every where in nature, and floating as fine dust in the atmosphere, settled on all bodies to develop only where the conditions of air, water and organic decomposition favored; others denied the existence of germs, and supposed that under the dissolving action of the water, the dead organic substance took on life and so came out as new beings.

Analogy afforded a strong argument for the first of these opinions. The second has often been sustained by appeals to researches claiming that animalcules were produced under circumstances in which all germs from external sources were excluded, and all present in the waters used had been destroyed. Frey and several other observers have thought that they had succeeded in securing these conditions and still had found their infusions populated with microscopic plants and animals; whence the conclusion that these organisms were a result of spontaneous generation.

It does not pertain to me to pronounce on the origin of microscopic plants, for this difficult subject must be left to botanists. But as regards animals, I do not hesitate to say that the experimental conditions required to prove the truth of spontaneous generation have not been realized by any of the predecessors of Mr. Pouchet. And are the researches of this naturalist, that have recently been communicated to the Academy, free from the objections which are made against earlier experiments? I believe not: and before mentioning some observations I have had occasion to make on this subject, I will briefly state the reasons that lead me to this conclusion.

I do not question the facts stated by Mr. Pouchet. The point is, Have these facts the significance attributed to them? I believe not. His experiment is briefly as follows. After having boiled some water and kept the liquid from contact with the air, he puts it into contact with pure oxygen, and introduces a certain quantity of hay, which had been previously enclosed in a flask and heated for a half hour in a stove whose heat was carried up to 100° C. or to the boiling point of water. The infusion thus prepared was hermetically sealed, and after some days Mr. Pouchet found infusoria developed in it.*

To make these facts sure proof that the animalcules obtained were not derived from the hay put into the infusion, it must be shown that the heat of the stove had destroyed all the germs. Mr. Pouchet presumes that this is true, because on boiling in water the spores of a *Penecillum* he has seen that they were decomposed. But this reason does not satisfy me.

In the first place, was the hay, although enclosed in a flask and kept thirty minutes in a stove at 100° C. (212° F.), really carried up to the temperature of boiling water? Mr. Pouchet believes it; but I think to the contrary, and I think that physicists and chemists will judge so too. The equilibrium of temperature under such conditions is not established so promptly as this; it appears to me probable that the hay, enclosed in a glass vessel and surrounded by air in repose, both substances bad conductors of heat, was in reality heated but little by the heat of the stove during the short time it was exposed to it.

But supposing that the hay was heated up to 100° C., can we then conclude that the germs had lost their vitality and were incapable of development? No, for there is an important distinction here to be recognized between the action of heat on organized bodies which contain water and on those which are in the dry state. This follows directly from the researches, already old, of our learned colleague, Mr. Chevreul. Although in ordinary circumstances death takes place when animals are exposed to a

* See page 253 of this volume.

temperature sufficient to determine the coagulation of the hydrated albumen in their tissues, we know that this is not always so in the case of those which have been previously dried. In fact, fifteen years since, Mr. Doyère made known that certain animalcules, such as the *Tardigrades*,* after being sufficiently dried would preserve their vitality for several hours while exposed in a stove whose temperature is much higher than that used by Mr. Pouchet for his flask of hay. I have seen these animalcules resist thus the very prolonged action of a stove whose temperature stood at 120° Centigrade (248° F.); and in the researches of Mr. Doyère, the heat of the ambiant medium was carried to 140° C. (284° F.) without death ensuing from the heat.

What is true for the *Tardigrades*, animals of a very complex structure, may also be true for the germs of Infusoria in general; and I conclude that nothing in the trials of Mr. Pouchet authorizes us to infer that the germs of the animalcules obtained by this naturalist were not in the hay that was used in his experiment. I will even say that the experiments of our correspondent do not seem to me to add any new probability in favor of the hypothesis of spontaneous generation.

I have often made analogous experiments; and I have always found that the living animalcules which appeared in water containing dead organic matters, were increasingly rare the more complete the precautions employed for protecting the liquids from the introduction of germs. In more than one trial, I should have believed that spontaneous generation had taken place under my own eye, had I not, on reflecting on the conditions under which I was operating, perceived sources of error, and on setting these aside, observed negative results to multiply.

I will not occupy the Academy with the general recital of these trials, but will ask permission to recount briefly a single series of experiments in which some infusions, that if exposed to the air would in all probability have given birth to animalcules, afforded none when the imprisoned matters in the hermetically sealed vessel had been subjected to a temperature high enough to cause the coagulation of the contained albuminoid substances.

I placed in two tubes, having the form of test-tubes, the water and the organic matters for the trial. One of these tubes, which was two-thirds filled with air, was then closed by means of a lamp, and both this and the other tube were then plunged into a bath of boiling water. The bath was kept in ebullition long enough to establish an equilibrium between the water outside

* The Tardigrade animalcules are minute worm-shape animals about a fortieth of an inch in length, belonging to the Rotatoria of Ehrenberg, and therefore much higher in structure than the ordinary Infusoria.

and the liquid of the two infusions; and then the tubes were allowed to cool and left to themselves, care being taken to examine the contents from time to time. After some days, I found animalcules in the tube which remained open to the atmosphere, but *not a single one in that which had been hermetically sealed.*

I have been accustomed to cite these experiments in my lectures, but had not thought of bringing them before the Academy, because negative results acquire importance only when they have been obtained constantly in a large number of trials, and also because the spontaneous generation of animals appears to me so little probable that I would not devote time to the repetition of researches on a subject which seems to be already settled. Only in view of the communication of our correspondent, and the interest that experimenting in this direction may excite in our young physiologists, have I been induced to bring out these facts among the reasons for still rejecting the hypothesis of spontaneous generation as an explanation of facts connected with the multiplication of animalcules.

An hypothesis which is not necessary in order to understand the phenomena made known by observations, and which is in flagrant discordance with all that analogy teaches us, seems to have no right to a place in science. It may be that chemistry will be able to make all the kinds of substances which occur in the constitution of living bodies; but as to the genesis of living organisms without the concurrence of vital force, I see no reason for believing it. Until more amply instructed, I shall therefore continue to think that in the animal kingdom there is no such thing as spontaneous generation, and that all animals, large and small, are subject to the same law, and can exist only when they have been generated by living beings.

2. *Remarks on the same occasion*, by Mr. PAYEN, Professor in the Conservatoire Imperial des Arts et Metiers.

Some time in 1843, there occurred an alteration of the bread at Paris by a rapid growth of cryptogamic vegetation; and after having determined in connection with Mr. Mirbel the cause of the phenomenon, which had produced some excited dissatisfaction among the people, I endeavored to determine the temperature at which the sporules of the *Oidium aurantiacum* lost their germinative power. These sporules were heated at first for an hour to 100° C. (212° F.) in a tube inserted in an oil-bath. A part were then withdrawn and exposed in the proper circumstances for growth; and germination took place. The remainder of the sporules were then heated to 120° C.; and they neither underwent change of color nor lost their property of germination. Finally, they were heated to 140° C., when their appearance

was altered, the color became reddish-orange in place of brownish-yellow, and the germinative power was destroyed.

These results sustain, as regards the lower orders of vegetation, the opinion expressed by Prof. Milne Edwards respecting animalcules.

3. *Remarks on the same occasion,* by A. DE QUATREFAGES.

I have often expressed on the subject of spontaneous generation similar opinions to those of Milne Edwards; and I now give my full adhesion to the conclusions of my learned associate. I take the floor only to communicate to the Academy an observation, which, although incomplete, confirms ideas now generally admitted. [De Quatrefages adds some facts sustaining his opinion.]

4. *Remarks on the same occasion,* by Dr. CLAUDE BERNARD.

Among a large number of experiments which I have made to ascertain the influence of saccharine substances in liquids where microscopic vegetation was developed, I will cite one, as it bears directly on this subject of spontaneous generation now under discussion.

On the 1st of September, 1857, I put into two glass flasks, each half a litre in capacity, about fifty cubic centimeters of a same dilute solution of gelatine in water to which some thousandths of cane-sugar had been added. The liquid was then kept boiling in the two flasks for a quarter of an hour, the tubular neck of each having been previously drawn out so that it could easily be sealed. Up to this point there was no difference between the flasks. Now, when the flasks were still boiling and filled with steam, a difference was begun by allowing ordinary air to enter one, and highly heated air the other. To accomplish this, while ebullition was going on, the neck of one of the flasks was connected with one of the extremities of a porcelain tube filled with fragments of porcelain and brought up to a red heat by a furnace; at the other extremity the porcelain tube was terminated in a glass tube of fine bore, so that the air should enter gradually and pass very slowly over the red-hot porcelain. Thus situated, the vapor of the liquid in ebullition rose into and filled the porcelain tube, and even passed out at the end of the fine tube. The lamp was then removed to arrest the ebullition; and by degrees the steam was condensed and the outside air (air of the laboratory) entered to take its place, passing through the red-hot porcelain tube above described. After the liquid had cooled, the flask was hermetically sealed at the neck.

The other flask was allowed to cool without any connection with the porcelain tube, and the atmospheric air entered freely. When the flask was cooled it was sealed like the other.

The two flasks were then placed in the same conditions, exposed to the light and to the ordinary temperature. After ten or twelve days, at the surface of the flask containing the ordinary air, vegetation was visible, a well-characterized mould, whilst in that which had received the heated air the liquid remained perfectly limpid, and without any thing on its surface. After a month the mould had much increased in the former, while nothing had appeared in the latter, except that the water had slightly lost its clearness. After six months (March 4, 1858) the mould remained stationary in the former, while in the other the liquid continued the same, without any trace of mould.

The extremities of the two flasks were now broken under mercury. In the case of the one with heated air, considerable mercury was absorbed, but none in the other. The air of the two flasks being analyzed, no oxygen was found in either. The air from the flask with ordinary air contained 13·48 per cent of carbonic acid, that of the other, in which no mould had formed, 12·43 per cent.

The liquid of the flask with ordinary air had a putrid and very disagreeable odor, while the other had none. These liquids were examined by Mr. Montagne; and our Associate ascertained that the mould developed in the flask with ordinary air was the *Penecillum glaucum*, which was in full fructification; in the other he found no trace of any vegetable or animal organism.

It is plain that this experiment, like those which have been before cited, is not favorable to the hypothesis of spontaneous generation.

5. *Remarks on the same occasion and subject by the chemist* DUMAS.

Dumas stated that he was in full agreement with his honorable Associates. For thirty years he had had under careful examination the question on which Prof. Milne Edwards had instructed the Academy with so high authority, and he had arrived at precisely the same conclusions.

He was incited to experiment on the subject by the publication of Mr. Frey, who had announced results analogous to those communicated to the Academy by Mr. Pouchet.

In his experiments he has assured himself that organized matters heated to 120° C. or 130° C. with water artificially made by means of hydrogen and oxyd of copper, and with artificial air in closed tubes, the glass of which had been recently heated to a red heat, produced neither vegetation nor animalcules. On opening these tubes and allowing ordinary air to enter, there was soon an appearance of vegetation and animalcules. These results had surprised him, as he was disposed to think that the germs of these plants and animalcules might be distributed in

the organized matter as well as in the air itself, and that certain of these germs might well be of a nature to resist a temperature of 100° C. or even a higher temperature.

As the Tardigrades when absolutely dry resist 140° C., and the sporules of *Oidium aurantiacum* 100° C. in a moist medium, it will not suffice in order to establish the hypothesis of spontaneous generation, that living beings should sometimes appear in boiling water in contact with artificial air and with the presence of organic matters that had before been heated, especially if these matters were heated when dry. When among these inferior animals and plants, life is suspended by absolute desiccation to return to action again on a return of humidity, the being so treated is in that state of latent animation which belongs to germs. It is hence a matter of astonishment that on putting heated organic matters into connection with oxygen and artificial water, we do not sometimes find living beings to appear. Even such an observation as this, would not therefore suffice to establish the theory of spontaneous generation, or prove that the germs of these beings were not previously deposited in the organic matters employed. But, in fact, whilst animalcules appear when the ordinary air has access, without this access under the precautions mentioned they do not appear.

6. *Note on Spontaneous Generation*, by JAMES D. DANA.

1. There is a well-known principle in the system of nature that deserves to be considered in this connection. The principle is so fully sustained by all research both in chemistry and zoology, including the important experiments above mentioned, that it may well carry with it great weight, and quiet both apprehension and expectation on this subject. It is this:—The forces in life and inorganic nature act in opposite directions, the former *upward*, the latter *downward*.

The vital force, in the organic substances it forms, *ascends* through vegetable and animal life to an exalted height in the scale of compounds at an extreme remove from saturation with oxygen; inorganic force *descends* towards the saturated oxyd. The former reaches a point which from its very elevation is one of great *instability;* the latter tends towards one of perfect *stability*. There is hence a counterpart or cyclical relation between the two great lines of action in nature.

As some readers of these remarks may not be familiar with chemistry, a further word of explanation is added.

When an element unites with its full allowance of oxygen, as determined by its affinities, it is in a sense saturated with it. Since the attraction of the elements for oxygen is the most universal and, in general, the strongest in nature, the oxyds as a

class are the most stable of compounds; the rocks, the earth's foundations, are made of them. But evanescence and unceasing change are in the fundamental idea of the living structure; and consequently the material of the plant or animal contains only oxygen enough to give increased instability to the combination. Moreover the compounds augment in instability, through this and other ways, with the rise in the grade of organic life, and reach probably their farthest extreme in this respect in the brain. Here then is the summit of the series of compounds which arise under the agency of life. The stable oxyd is at the lower end of the series in nature, the material of the brain at the upper. Passing from the latter condition towards the former is therefore a real descent; and it is the natural downward course of inorganic forces;—while passing towards the latter is as truly an ascent; it is the counter-movement of life.

The plant through its vital functions may take carbonic acid, and from it, continue to elaborate the organic products constituting vegetable fibre, until a whole tree of such material is made, and then produce the higher material of the flower and seed. The animal may then go to the plants and use them in making a still higher class of products, muscular fibre and nerve. After all this is done, now turn over the material to the action of chemical and physical forces,—and the work of years of life is soon pulled down from its height, and one part after another descends towards that state of comparative inactivity, the condition of an oxyd. Chemistry makes organic products by commencing with those of a higher grade than the kind to be made, but not otherwise. Albumen is a prominent material of the egg; and chemistry has not succeeded in making dead albumen, much less living.

The very relation of life to chemistry is therefore evidence that chemistry cannot make life; it works in just the reverse direction. And in this reciprocal relation one of the profoundest laws of nature is exhibited. It leads the mind to recognize one author for both, and not to imagine that one side in the cycle has generated the other.

2. There is another consideration, which, if it has not the force of demonstration, may help the mind to understand the extent of the transition from dead matter to living.

(*a*) In ordinary *inorganic* composition, there is the simple formation of inorganic particles, and, on consolidation, their aggregation into crystals, the perfect individuals of inorganic nature. With the enlargement of the crystal there is no gain of new powers or qualities: it simply exists. In fact, in entering this state of perfection, there is *a loss of latent force;* for the gas is the highest condition of stored or magazined force in inorganic

nature, the liquid the next, and the solid the lowest, this condition of power being related directly to the amount of heat.

(*b*) The *plant* grows from its germ, enlarges, accumulates force storing it away in vegetable fibre, and accomplishes its highest functions in its blossoms and fruit. But there is here only *latent or stored force* generated, besides that which is used up in growth, and *no mechanical* force. The minute spore or reproductive cellule of some seaweeds has locomotive power, but it is lost at the commencement of germination; and the plant is ever after as incapable of self-locomotion as a rock.

(*c*) In the *animal*, there is not only a storing of force in animal products (the fifth and highest grade of stored force in nature), but there is also increasing *mechanical* force from the first beginning of development. It is almost or quite zero in the germ; but from this, it goes on increasing until in the horse, it gets to be a one-horse power; or in the ant, a one-ant power; and so for each species. And in addition to mechanical force, there is, in the higher group, the more exalted *mental force;* for the mind, while not itself material, is yet so dependent on the material, that its action draws deeply upon the energies of the body. To make an animal germ is then to make a particle of albuminoid substance that will grow and spontaneously develop a powerful piece of enginery, and continue a system of such generations through ages of reproduction.

The creation of any such animal germ out of dead carbon, nitrogen, hydrogen and oxygen, or any of their dead compounds, is therefore opposed to all known action or law of chemical forces; and as much so, the creation of a vegetable germ from inorganic elements.

Moreover, it is seen that the two kingdoms, the vegetable and animal, have their specific limits and comprehensive reciprocal relations, and are obviously embraced as parts of one idea in a single primal plan:—not a plan involving the generation of one out of the other, or of either out of inorganic nature, but of the three, through some Creating Power higher than all.

Art. XLIX.—*Eruption of Mauna Loa, Hawaii.*

The central crater of Mauna Loa is again in action. According to a letter from the Rev. T. Coan of Hilo and the public papers, the eruption began on Sunday the 23d of January last.

This is the fourth great eruption since the beginning of the year 1843. Previous to that time *Kilauea*, the still more spacious crater on the eastern slopes of the mountain, had been often in violent action, while the summit crater was quiet, and

had long so remained. The account of boiling fires in the pit at the summit, brought down by the unfortunate Douglas in the year 1834 was disbelieved, because of the accustomed quiet of the crater, in addition to some evident exaggerations in his description and the absence of any manifestations of fires distinguishable from the foot of the mountain.*

Kilauea discharged its lavas through the sides of the mountain in 1823, June 1832, and June 1840. The lower pit, which was 400 feet deep after the eruption of 1840, had filled up again by 1848, and the bottom had become raised by the overflows of the pool even above the level of the old black ledge. In the course of these changes a broad dome was raised over the site of the great lake of boiling lavas in the southwestern extremity of the crater; in a basin at the centre of the dome the lavas were still smoking, and boiling or subsiding with its varying phases. Eleven years have since passed, and Kilauea has had no new eruption. Mr. Coan in his recent letter (Feb. 3, 1859,) observes:

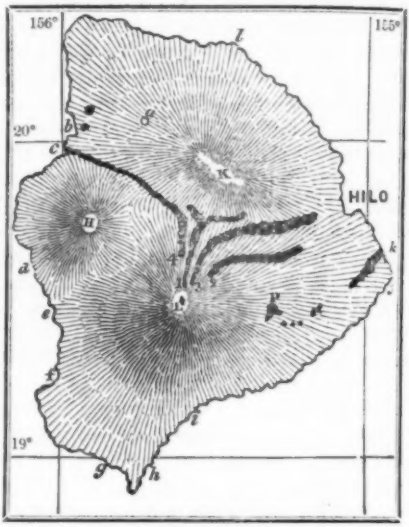
"I was at Kilauea last August. No striking changes have occurred there for three years. The great lake now some 500 feet in diameter—still boils and sputters lazily in the centre of the deep depression or basin which occupies the locality of the old dome and the still older lake of far larger dimensions. The action in it alternates between a refrigeration and a breaking up of the whole surface with intense ebullition. Mr. Sleeper of Charlestown, tells me that during a recent visit to this pool he saw it throw up jets of fire 100 feet high."

After the last eruption of Kilauea, the action of the central crater of Mauna Loa (called Mokua-weo-weo) began to revive. In January 1843 there was an outflow which commenced at a height of 13,000 feet, and extended on for 25 or 30 miles running northward toward Mauna Kea, and part northwestward. It is No. 1 in the annexed map. Again on the 17th of February, 1852, another eruption (No. 2,) took place, making its first appearance near the summit, but after three days, beginning its principal outflow from a point 10,000 feet above the sea, where there was a fountain of lava 1000 feet in diameter and 300 to 700 feet high described by Messrs Coan, Fuller, and others (this Journal, [2], xiv, 219, 254, xv, 63). It flowed off to the eastward with a winding course for about 40 miles. In August 1st, 1855, a third eruption (No. 3 on the map) took place, beginning at a height of about 12000 feet, according to Mr. Coan, and continu-

* This word foot, although correctly used, is sure to convey a wrong impression unless it is remembered that Mauna Loa has a breadth of 50 miles, and a height of only 2¾ miles. By laying off an equilateral triangle having the base 20 times the height, and then rounding a little the top, an approximate section will be obtained. It will be improved by extending the eastern slope one fourth farther at an angle diminishing gradually to one degree. The crater Kilauea is but 3,970 feet above the sea, although 18 to 30 miles from the coast.

ing its progress for a year and a half, it stopped within five miles of Hilo. (This Journal, xxi, 100, 139, 237, 241, xxii, 240, xxiii, 435).

Finally, on the 23d of last January, according to Mr. Coan, a fourth great outflow commenced: making three eruptions at intervals of 3½ years, and four from January, 1843. Mauna Loa is hence quite taking the lead in activity among the earth's larger volcanoes. And as Kilauea has remained quiet since the older crater began its outbreaks, it would seem as if the mountain had transferred to the latter its principal activity. Yet according to all reports, hitherto, Kilauea, although the larger crater and an open vent at a level 10,000 feet lower, has shown no signs of sympathy in its lavas with the violent action at the summit.



ISLAND OF HAWAII.

L, Mauna Loa; K, Mauna Kea; H, Mauna Hualalai; P, Kilauea or Lua-Pele; 1, Eruption of 1843; 2, of 1852; 3, of 1855; 4, of 1859; *a*, Waimea; *b*, Kaweihae; *c*, Waiaalii; *d*, Kailua; *e*, Kealakekua; *f*, Kaulanamauna; *g*, Kailiki; *h*, Waiohinu; *i*, Honuapo; *j*, Kapoho; *k*, Nanawale; *l*, Waipio. The courses of the currents, excepting that of No. 4, are from a manuscript map by Mr. Coan.

From the letter of Mr. Coan and the notices in the public paper of Honolulu referred to, we derive the following accounts of the recent eruption. It has yet been but imperfectly explored.

The editorial writer in the "Commercial Advertiser" of Honolulu, in his visit to the region, reached the central plain of the island between Mauna Loa, M. Kea and Hualalai, elevated about 4000 feet above the sea. He says:

"This new crater, for which we can find no native name except '*Pele hou*,' (the new eruption,) is located on the northern slope of Mauna Loa, at an elevation of, say 6,500 feet, above the sea, and at an equal distance below the level of the summit of the mountain. It is some ten miles or so more to the westward, and about 4000 feet lower down, than the last eruption of 1855. The course of the stream, from its source to the sea, we judge to be nearly N. W. by N. The crater bears due east from Kailua by the compass, and is about 24 miles from that harbor in a straight line. Its latitude, as near as we are able to determine without instruments, is 19° 37′, and the longitude 155° 40′.

From the distance at which we observed the crater, about ten miles, and from various points of observation, it *appeared* to be circular, its width being about equal to its breadth, and perhaps 300 feet across the mouth. This may be too moderate an estimate, and it may prove to be 500 or even 800 feet across it. The rim of the crater is surrounded or made up of cones formed from the stones and scoria thrown out. The lava does not simply run out from the side of the crater like water from the side of a bowl, but is thrown up in continuous columns, very much like the Geyser springs, as represented in school geographies. At times this spouting appeared to be feeble, rising but little above the rim of the crater, but generally, as if eager to escape from the pent-up bowels of the earth, it rose to a height nearly equal to the base of the crater. But the columns and masses of lava thrown out were ever varying in form and height. Sometimes, when very active, a spire or cone of lava would shoot up like a rocket or in the form of a huge pyramid to a height nearly double the base of the crater. If the mouth of the crater is five hundred feet across, the perpendicular column must be eight hundred to one thousand feet in height! Then by watching it with a spyglass, the columns could be seen to diverge and fall in all manner of shapes, like a beautiful fountain.

This part of the scene was of wonderful grandeur. The fiery redness of the molten lava, ever varying its form, from the simple gurgling of a spring to the hugest fountain conceivable, is a scene that will remain on the memory of the observer till death. Large masses of red-hot lava, weighing hundreds if not thousands of tons, thrown up with inconceivable power to a great height, could be seen occasionally falling outside or on the rim of the crater, tumbling down the cones and rolling over the precipice, remaining brilliant for a few moments, then becoming cold and black, and lost among the surrounding blocks of lava.

A dense heavy column of smoke continually rose out from the crater, but always on the north side and took a northeasterly direction, rising in one continuous column far above the mountain, to a height of perhaps 10,000 feet from the crater.

On leaving the crater, the lava stream does not appear at the surface for some distance, say an eighth of a mile, as it has cut its way through a deep ravine or gulch, which hides it from the eye. How deep this gulch may be is all conjecture, as it is impossible to get near enough to look into it, but it probably is several hundred feet deep. The first then that we see of the lava after being thrown up in the crater is its branching out into various streams some distance below the fountain head. Instead of running in one large stream, it parts and divides into a great number, spreading out over a tract of five or six miles in width. For the first six miles from the crater, the descent is rapid, and

the flow of the lava varies from four to ten miles an hour, according to the descent. But after it reaches the plain, where it is level, the stream moves more slowly. Here the streams are not so numerous as higher up, there being a principal one which varies and is very irregular, from an eighth to half a mile in width, though there are frequent branches running off from it. This principal stream reached the sea near Wainanalii, or about fifteen miles south of Kawaihae, on the 31st, after a flow of eight days from the time that the eruption commenced on the 23d of January. This stream, on reaching the sea, spread out to about half a mile in width, and clouds of steam rose several hundred feet high, and covered the region.

The length of the lava stream from the crater to where it enters the sea at Wainanalii, we estimate to be thirty-eight miles. For the first ten miles from the crater, the flow is divided into many streams—perhaps as many as fifty—but lower down, it is confined to one or two principal streams with frequent branches to the right and left."

Another writer in the same paper, L. Lyons, dating Waimea, Feb. 4, makes the important statement that an outbreak took place first "very near the top of the mountain," and that the outflow at 6500 feet was only a continuation of the eruption.

"On Sabbath, Jan. 23d, volcanic smoke was seen gathering on Mauna Loa. In the evening the mountain presented a grand yet fearful spectacle. Two streams of fire were issuing from two different sources, and flowing, apparently, in two different directions. The whole region, earth and heaven, were lighted up, and even the interior of our houses received the lurid volcanic light direct from its source. In the morning of the second day, we could discern where the eruptions were. One appeared to be very near the top of the mountain, but its stream and smoke soon after disappeared. The other was on the north side, further below the top, and was sending out its fires in a northwesterly direction. On the second and third nights, the dense smoke and clouds prevented us from a fair view of the action: but on the four following nights we had a view—and such a scene! It seemed as though the eye could never weary in gazing at it. The burning crater seemed to be constantly enlarging and throwing up its volumes of liquid fire above the mouth of the crater—I will not venture to say how high—and the fiery stream rolled onward and onward, still adding grandeur and terror as it proceeded, till, on the morning of the 31st, about sunrise, the stream was compelled, though reluctantly, to stop, by meeting the waters of the ocean. Even then its resistless and opposing energy carried it on some distance into the sea. The poor inhabitants of Wainanalii, the name of the village where the fire reached the ocean, were aroused at the midnight

hour by the hissing and roaring of the approaching fire, and had but just time to save themselves. Some of the houses of the inland portion of the village were partly surrounded before the inmates were aware of their danger. Wainanalii is near the northern boundary of North Kona, and about twelve or fourteen miles from Kawaihae. It is, of course, all destroyed, and its pleasant little harbor filled up with lava. The volcanic stream was one mile wide or more in some places, and much less in others. It crossed the Kona road and interrupted the mail communication. The whole distance of the flow from the crater to the sea is some forty miles.

Last night (the 3d Feb.) the volcano was in full blast, and the burning stream seems to have taken another direction."

Mr. Coan writes from Hilo on Feb. 3, having projected but not yet undertaken a journey of exploration.

"On the 23d ult. Mauna Loa opened near its summit and out rushed a flood of lavas, which made unusually rapid progress in its descent. So vigorous was the action and so immense the floods of lava poured out, that, for a long time, there seemed no blackening and refrigerating process on the surface, but a vast incandescent river rushing madly down and throwing up such an intense glare as appeared like a consuming mountain and a burning firmament. The course of the stream was north, until it was diverted by the base of Mauna Kea, when it turned west-northwest and flowed towards the opposite coast of our island. So great has been the light and so vehement the action, that many pronounce it the greatest eruption we have ever had in so short a time.

At the present time there is no light and but little smoke visible from Hilo at the summit or side of the mountain, but the light is still intense all over the isthmus between the mountains.

The present eruption commenced very near the point of the one in 1843 [at the summit] which cost me such fatigue and danger in exploring. The direction of the lava stream or streams is, also, very nearly the same."

This eruption appears to have been similar to that of 1855 in its jet or fountain of lavas at the great outbreak. The first outbreak at the summit shows that the column of lavas of Mauna Loa had the height of about 13,000 feet, or 9500 above the level of the bottom of the crater of Kilauea. The second outbreak at a height of 6500 feet, was therefore 6500 feet below the first; and it proves that a column of 6500 feet of heavy liquid lavas was acting by its pressure in producing the fountain of lavas described. Like all the preceding eruptions of the grand old mountain, there were no great shakings or subterranean sounds, so common in the more blustering action of little Vesuvius. There is rock material enough in Mauna Loa to make *one hundred and twenty-five* Vesuviuses. J. D. D.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

1. *Researches on the Thermic action of the Solar Spectrum.*—MÜLLER has communicated an interesting memoir upon the subject of the thermic action of the solar spectrum, a subject which has hitherto attracted comparatively little attention. In his introduction, the author in the first place, briefly reviews the experiments of Melloni, who confined his attention almost exclusively, to the determination of the position of the maximum temperature in the spectrum. Experimenting with a prism of rock salt, Melloni found the maximum of heat in a position which lies about as far outside the red limit of the spectrum as the place of passage from the green to the blue is distant from the red end. The Italian physicist gave however no numerical data from which the thermic curve in the spectrum could be deduced. Melloni also, who had previously adopted the opposite view, afterward maintained the perfect identity of rays of light and heat of the same degree of refrangibility. This last view as to the identity, was also adopted by Masson and Jamin, who found that all the rays of heat which lie within the visible spectrum are equally well transmitted by rock salt, rock crystal, alum, glass, etc. That consequently the unequal transcalency of these substances is only occasioned by their unequal capacity of absolving the rays of heat which are less refrangible than the red. They have not however, published the details of their experiments.

The merit of first communicating measurements of the temperature at different points of the spectrum, obtained by means of the thermoelectric battery, belongs to Franz. He found that in a spectrum which is pure enough to exhibit Fraunhofer's lines the thermic effects are so slight that measurements are out of the question. As Franz' numerical data were obtained by means of a flint glass prism, which absorbs a considerable number of dark rays of heat, the curve of intensity, constructed upon his numbers, does not correspond to the distribution in a complete heat spectrum. This can only be obtained by means of a prism of rock salt. The instruments employed by Müller, consisted of a thermo-electric pile of 40· pairs of bismuth and antimony, of a multiplier of 3700· windings, and of a linear thermo-electric pile of 15· pairs. The sun's rays with which he experimented, were introduced into a dark room, by means of a Silbermann's heliostat.

Before undertaking experiments on the distribution of heat in the spectrum, the author endeavored to attain his object by investigating the absorbing action of colored liquids upon the rays of heat. This method requires us to assume the identity of rays of light and heat of the same degree of refrangibility. The liquids employed were enclosed between parallel glass plates, and optically analysed by means of a prism. They consisted of pure water, a solution of cochineal, a solution of bichromate of potash, a solution of chlorid of copper and a solution of ammonia sulphate of copper.

By directly comparing the quantity of heat transmitted through these liquids, with the character of the light also transmitted, the author found that the heating power of the less refrangible rays of the solar spectrum, namely of the red, orange and yellow rays, is much greater than that of the green, blue, indigo and violet.

After some preliminary experiments with a glass prism, the author proceeded to use a prism of rock salt, with the linear thermo-electric battery. From the numerical data obtained, he constructed the curves of thermic intensity in prisms of crown-glass, and of rock salt. This curve shows that the dark rays of heat in the spectrum, beyond the red, occupy, in the case of crown-glass, a space which is almost as long as the entire visible spectrum, and this result corresponds nearly with those of Franz. In the spectrum obtained by means of a prism of rock salt, the thermic maximum lies still farther outside of the red, than in the case of the spectrum with the glass prism, and the actual distance corresponds with the measurements of Melloni above mentioned. The dark thermic prolongation of the spectrum is, according to these experiments not greater for rock salt than for glass.

The above experiments show that the dark rays of heat which are contained in the solar spectrum, extend far beyond the red limit of the visible rays, and that for a crown-glass spectrum, Fraunhofer's line B lies about in the middle between the violet end of the spectrum and the extreme dark rays of heat. And since the index of refraction of crown-glass for the line H is about 1·546 and for B about 1·526, it follows that the index of refraction of the extreme dark rays of heat in the solar spectrum, is about 1·506.

The results of the author's experiments, as we shall see farther on, do not agree with Cauchy's formula for dispersion, which is intended to express the relation between the wave length and the index of refraction. This relation the author endeavors to express by an empirical formula of the form

$$w = a + be + ce^2 \quad . \quad . \quad . \quad . \quad (1.)$$

in which w represents the wave length, e the index of refraction, and a, b and c constants determined by experiment. This formula gives for the wave length of the extreme rays of heat in the solar spectrum and for an index of refraction of 1·506, the value

$$w = 0{\cdot}00177^{\text{mm}}.$$

The same result very nearly is obtained by a graphical construction, which gives

$$w = 0{\cdot}0019^{\text{mm}}.$$

The author takes the mean of these two determinations, namely,

$$w = 0{\cdot}00183^{\text{mm}},$$

as the wave length of the extreme dark rays.

The wave length of the extreme fluorescent rays in the sun's light is, according to Esselbach's experiments, 0·0003.

The wave length 0·0006, corresponding to Fraunhofer's line D in the orange, is the next lower octave of these most refrangible rays.

The second lower octave with a wave length 0·0012 falls in the middle of the dark rays of heat of the solar spectrum.

The third lower octave with a wave length 0·0024 falls outside of the limit of least refrangibility.

In all therefore the solar spectrum embraces somewhat more than two and a half octaves.

In conclusion, the author investigated the distribution of heat in the diffraction spectrum, the apparatus employed being a ruled surface of smoked glass (*Russgitter*), similar to that employed by Eisenlohr, and a linear thermo-electric battery of fifteen pairs, but found the thermic effects so small that he was obliged to abandon the hope of obtaining reliable results in this manner. He however deduces the curve of distribution of the heat in the diffraction spectrum from that of the refraction spectrum. From this curve, it appears that in the diffraction spectrum the dark rays of heat occupy a space which is about three and a half times as broad as the whole visible spectrum.

In a second memoir, the author returns to the subject of the disagreement of his experiments with Cauchy's formula for dispersion above alluded to. If n represents the index of refraction for a particular ray, λ the corresponding wave length, Cauchy's formula for dispersion is

$$\frac{1}{n^2} = a + \frac{c}{\lambda^2} \qquad (1.)$$

neglecting the higher powers of $\frac{1}{\lambda}$.

If we substitute in this equation the values $\lambda = 0{\cdot}000396$ for the line H, and $n = 1{\cdot}546$ for crown-glass, we have

$$0{\cdot}41839 = a + c.6376900. \qquad (2.)$$

If we substitute the value $\lambda = 0{\cdot}00069$ for the line B and $n = 1{\cdot}546$ we have

$$0{\cdot}42943 = a + c.2100400. \qquad (3.)$$

By combining these two equations we find

$$a = 0{\cdot}43436$$

$$c = -0{\cdot}0000000023477,$$

and substituting these values in equation (1.) we have

$$\frac{1}{n^2} = 0{\cdot}43436 - \frac{0{\cdot}0000000023477}{\lambda^2}. \qquad (4.)$$

This is Cauchy's formula for the special case that n represents the index of refraction for crown-glass, and λ the corresponding wave length in the air. For $\lambda = \infty$ we have

$$\frac{1}{n^2} = 0{\cdot}43436 \text{ or } n = 1{\cdot}516,$$

and this is the least value of the index of refraction which is possible according to Cauchy's formula. Hence it appears that according to Cauchy's formula when the index of refraction diminishes from 1·546 to 1·526, the wave length diminishes from $0{\cdot}000396^{mm}$ to $0{\cdot}00069^{inm}$; when however the index diminishes from 1·526 to 1·517 the corresponding wave length ought, according to the formula, to increase from 0·00069 to infinity, a result which to say the least is extremely improbable.

For all values *less* than 1·517 and therefore for 1·506, equation (4.) gives imaginary values for λ. But by taking into consideration the influence which the ponderable particles exert upon the atoms of the ether which was neglected by Cauchy, Redtenbacher develops the formula

$$\frac{1}{n^2} = a + b\lambda^2 + \frac{c}{\lambda^2} \cdots \qquad (5.)$$

This formula agrees with observation very well within the limits of the visible spectrum. When applied to Müller's index of refraction 1·506 for the extreme heat rays it gives for the corresponding wave length λ the value 0·0048^{mm}, which is more than twice as great as that above determined by the author. Müller remarks that this difference is not surprising when we consider how uncertain is the application of empirical formulas far beyond the limits for which their coefficients are determined. In any event the value $\lambda = 0{\cdot}0048^{mm}$ is much nearer the truth than that deduced from the purely empirical formula. If we adopt this determination, 0·0048^{mm} for the wave length of the extreme dark rays of heat, we find that the entire solar spectrum embraces four complete octaves, of which not quite one is made up of the visible spectrum.—*Pogg. Ann.*, cv, 337, 543. W. G.

2. *On the Preparation of Chromate of Lead, for use in Elementary Analyses;* by Dr. H. Vohl, (Liebig's Annalen, April 1858, p. 127, cited from Chem. Gazette, No. 380, p. 319).—The employment of chromate of lead in elementary analyses, in which it has many advantages over peroxyd of copper, is considerably limited, partly by its cost, and partly by its troublesome preparation; moreover, it could not hitherto be restored to its original condition like oxyd of copper which has been used, so that after it has served twice or at the utmost three times, it has become completely useless. The behavior of the nitrates to oxyd of chromium at a red heat, led the author to examine into the action of nitrate of lead upon the oxyd of chromium. He mixed together one equivalent of each substance in fine powder, and heated the mixture in a porcelain crucible over the spirit-lamp. A considerable reaction very soon took place. The mass caked together, and a great quantity of nitrous acid was evolved. When the evolution of gas had ceased and the mass was more strongly heated, it fused, and on cooling furnished a radiately crystalline body of a dark reddish-brown color, which, when triturated, gave a brownish-yellow powder, and proved to be pure chromate of lead. When this salt is employed in elementary analyses, it is principally only the chromic acid that is deprived of its oxygen; and used chromate of lead may be again converted into the pure salt by moistening it with nitric acid and afterwards calcining it.

3. *On the Solubility of Sulphate of Strontia in Nitric Acid, Muriatic Acid, and Acetic Acid;* by R. Fresenius, (Liebig's Annalen, May, 1858, p. 220, cited from Chem. Gazette, No. 381, p. 338).—According to the author's previous experiments, 1 part of sulphate of strontia dissolves in 11,000 to 12,000 parts of water containing a little muriatic and sulphuric acid, that is, in a fluid such as is obtained when chlorid of strontium is dissolved in water and the strontia is precipitated by an excess of sulphuric acid. Sulphate of strontia is, however, unequally soluble in fluids containing a somewhat larger amount of nitric acid, muriatic acid, and even acetic acid. This must be taken into consideration in analyses.

a. Pure freshly precipitated sulphate of strontia was digested in the cold for two days with dilute sulphuric acid of spec. grav. 4·8. 150 grams of the filtrate left 0·3451 gram, so that 1 part dissolved 435 parts. In a second experiment the proportion was 1 : 429. The average is 1 : 432.

b. Another portion of sulphate of strontia was digested in the cold for two days with dilute muriatic acid of spec. grav. 8·5. 100 grams left 0·2115, and another 100 grams 0·2104 gram. The average solubility of sulphate of strontia in muriatic acid of the above strength is therefore expressed by the proportion 1 : 474.

c. A third portion was digested in the cold for two days with pure dilute acetic acid containing 15·6 per cent of hydrated acetic acid. 100 grams of the filtrate left 0·0126 and 0·0129 gram. This gives the average 1 : 7843.

4. *Ammoniacal Solution of Protoxyd of Nickel, a means of distinguishing Silk and Cotton;* by Professor SCHLOSSBERGER, (J. f. pr. Chem., lxxiii, p. 369, cited from Chem. Gazette, No. 383, p. 372).—The violet-blue solution of freshly precipitated hydrate of protoxyd of nickel exerts an extremely remarkable action upon silk. If silk threads be brought in contact with a drop of this solution under the microscope, peculiar vermicular movements are observed in it, and at the same time they swell up considerably and acquire a yellow color. Soon afterwards the outlines become pale, in part (with raw silk) accompanied by considerable inflations or ruptures of the external envelopes of the fibres, and finally complete solution takes place. If silk be thoroughly kneaded up in a test-glass by means of a glass rod with the blue solution of nickel, it soon becomes of a brownish yellow color, resembling that of hydrated oxyd of iron; it then becomes slippery and gelatinous, and at last furnishes a brownish yellow solution.

If the silk fibres be washed with water in the first stage of their alteration by the author's new reagent, all further action ceases; in later stages of change, they are also fixed by washing. The same thing is effected by a drop of weak acid, by the addition of which the fibre also loses somewhat in volume, and becomes colorless.

Solutions of alkaline salts do not precipitate the solution of silk, nor do solutions of sugar and gum. It is remarkable that a solution of $Cl\,NH^4$ restores the original violet-blue color to the brownish yellow solution of silk in $NiO\,NH^3$, without separating anything. The solution of silk and nickel is abundantly precipitated by acids, and this precipitate (in colorless flakes of the aspect of hydrate of alumina) is permanent, when the acids are not too strong. The fluid exhibits a greenish color.

Cellulose (cotton) is not at all altered, even by immersion for several days in the solution of $NiO\,NH^3$; after lying in it for three days, the fibres of cotton still presented their original form under the microscope, and there was no trace either of swelling or coloration. Potato-starch also did not swell up in it; inuline was gradually dissolved.

No analogous action has yet been produced upon silk by means of solutions of CoO, ZnO, and Al^2O^3 in NH^3. In the coloration, swelling, and solution of silk by NiO, it is essentially a matter of indifference whether the silk employed be raw silk, or silk deprived of its dressing by boiling.

5. *The Discovery of the Composition of Water*, (Athen., No. 1635, Feb. 26, 1859).—Mr. Bennett, of the British Museum, has addressed a letter to Sir Benjamin Brodie, Bart., which contains indisputable evidence in favor of Cavendish's claim to the discovery of the composition of water. The evidence was discovered by the late Robert Brown, Esq., and is not derived from any unpublished document, but forms part of a section of De Luc's 'Idées sur la Météorologie,' which, although specially entitled "*Anecdotes relatives à la découvertes de l'Eau sous la forme d'Air*, appears entirely to have escaped the notice of those who have advocated Cavendish's claims. It is the more conclusive as coming from De Luc, the "*ami zélé*," as he justly terms himself, of Watt, and who, in relation to this question, believed himself "à portée d'en connoître toutes les circonstances."

The testimony of De Luc is as follows:—"Vers la fin de l'année 1782, j'allai à *Birmingham*, où le Dr. Priestley s'étoit établi depuis quelques années. Il me communiqua alors que, M. Cavendish, d'après une rémarque de M. Warltine, qui avoit toujours trouvé de l'eau dans les vases où il avoit brûlé un mélange de *l'air inflammable* et *d'air atmosphérique*, s'étoit appliqué à découvrir la source de cette eau, et qu'il avoit trouvé qu'un mélange *d'air inflammable* et *d'air déphlogistique* en proportion convenable, étant allumé par l'étincelle électrique, se convertissoit tout entier en *eau*.—Je fus frappé au plus haut degré de cette découverte."—*Idées sur la Météorologie*, Tome 2, 1787, pp. 206–7.

The italics and inverted commas are De Luc's own.

In this communication, made by Cavendish to Priestley, the theory of the composition of water is clearly indicated. The two gases—known to have been hydrogen and oxygen—were mixed together *in due proportion*, and by means of the electric spark were *entirely converted* into water. Referring to one of Cavendish's experiments, as recorded in his Journal, Lord Jeffrey, the most candid and judicious of Watt's advocates, has said, "If he (Cavendish) had even stated in the detail of it that the airs were *converted*, or *changed*, or *turned* into water it would probably have been enough to have secured to him the credit of this discovery as well as to have given the scientific world the benefit of it in the event of his death before he could prevail on his modesty to claim it in public."—*Edinburgh Review*, vol. 87, p. 125.

The evidence which this distinguished critic and judge regarded as sufficent to establish Cavendish's claim is now afforded, not by a note in his private journal, but by the testimony of the zealous friend of Watt, who states that it was communicated to Priestley towards the end of 1782, that is to say, several months before Watt drew his own conclusions from Priestley's bungling repetition of Cavendish's experiments. It was, moreover, published to the world and suffered to remain uncontradicted while all the parties were alive and in frequent intercourse with the author and with each other.

It is a remarkable fact that notwithstanding all the researches made on many occasions during the past half-century on the claim to the discovery of the composition of water, and even within the past year by eminent *savants*, the evidence published by De Luc, in 1787, remained undiscovered, with an exception, that being, as above mentioned, the late Robert Brown, Esq., and this is the more remarkable when we remember

that De Luc's chapter, already referred to, is especially devoted to anecdotes on the subject in question.

[We happen to know that this knowledge had long been in Mr. Brown's possession, at least for the last nine or ten years of his life, during which the water-controversy has been so rife, if not from the time when he furnished Cavendish's biographer with incidental information; also that he regarded it as decisive of the controversy. So remarkable a retinence in such a case is probably unparalleled, but is perfectly characteristic. It is to be hoped that Mr. Brown has left some record or indication to show how he reconciled De Luc's statement, in 1787, of what occurred in 1782 with his (De Luc's) letters to Watt in 1783–4, now published in the Watt correspondence. The only apparent solution of this new enigma, consistent with the idea of De Luc's truthfulness, is that he had at the time misunderstood Priestley's verbal communication, but had been afterwards corrected by Priestley. That the name of "Cavendish" is not a *lapsus* for that of Watt is pretty certain. So, De Luc's statement, published in 1787,—at a time when Watt and Cavendish were in personal communication—may be regarded as his own reversal of the views he had expressed in his correspondence with Watt, and even as an indication of the understanding of the parties at the time. And it is singular that its republication now should close the long controversy which followed the resuscitation of this correspondence by Arago.—Eds.]

6. *On the Electric Conducting-Power of the Metals;* by Augustus Matthiessen, Ph.D., (L. E. and D. Phil. Mag., vol. xvi, p. 219).—The following values for the conducting power of the metals were determined in the Physical Laboratory at Heidelberg, under the direction of Professor Kirchhoff, by the same method as is described in the "Philosophical Magazine," Feb. 1857.

	Conducting Power at Temp. in Centigrade degrees.	
	° 100	° 0
Silver,		
Copper, No. 3,	77·43	18·8
Copper, No. 2,	72·06	22·6
Gold,	55·19	21·8
Sodium,	37·43	21·7
Aluminium,	33·76	19·6
Copper, No. 1,	30·63	24·2
Zinc,	27·39	17·6
Magnesium,	25·47	17·0
Calcium,	22·14	16·8
Cadmium,	22·10	18·8
Potassium,	20·85	20·4
Lithium,	19·00	20·0
Iron,	14·44	20·4
Palladium,	12·64	17·2
Tin,	11·45	21·0
Platinum,	10·53	20·7
Lead,	7·77	17·3
Argentine,	7·67	18·7
Strontium,	6·71	20·0
Antimony,	4·29	18·7
Mercury,	1·63	22·8
Bismuth,	1·19	13·8

Alloy of Bismuth 32 parts, Antimony 1 part,	0·884	24·0
Alloy of Bismuth 12 parts, Tin 1 part,	0·519	22·0
Alloy of Antimony 2 parts, Zinc 1 part,	0·413	25·0
Graphite, No. 1,	0·0693	22·0
Graphite, No. 2,	0·0436	22·0
Gas-coke,	0·0386	25·0
Graphite, No. 3,	0·00395	22·0
Bunsen's Battery-coke,	0·00246	26·2
Tellurium,	0·000777	19·6
Red Phosphorus,	0·00000123	24·0

All the metals were the same as those used for my thermo-electric experiments, with the exception of cadmium, which was purified by my friend Mr. B. Jegel.

The alloys of bismuth-antimony, bismuth-tin, antimony and zinc were determined in order to ascertain, whether, as they give, with other metals, such strong thermo-electric currents, they might be more advantageously employed for thermo-electric batteries than those constructed of bismuth and antimony.

Coppers No. 1, 2, 3 were wires of commerce. No. 1 contained small quantities of lead, tin, zinc, and nickel. The low conducting power of No. 1 is owing, as Prof. Bunsen thinks, to a small quantity of suboxyd being dissolved up in it.

Graphite No. 1 is the so-called pure Ceylon; No. 3 purified German, and No. 2 a mixture of both. The specimens were purified by Brodie's patent and pressed by Mr. Cartmell, to whom I am indebted for the above.

The conducting power for gas-coke, graphite, and Bunsen's battery-coke increases by heat from 0° to 140° C.; it increases for each degree 0·00245, *i. e.* at 0° C. the conducting power =100, and between the common temperature and a light red heat about 12 per cent. The following metals were chemically pure:—Silver, gold, zinc, cadmium, tin, lead, antimony, quicksilver, bismuth, tellurium. Those pressed were sodium, zinc, magnesium, calcium, cadmium, potassium, tin, lead, strontium, antimony, bismuth, tellurium, and the alloys of bismuth-antimony and bismuth-tin. The way in which these wires were made is described in the "Philosophical Magazine" for February, 1857.

II. MINERALOGY AND GEOLOGY.

1. *Note on Rammelsberg's results with regard to the Composition of the Titanic Iron Ores;* by JAMES D. DANA.—In this volume, at page 127, an abstract is given of the important researches of Prof. Rammelsberg on the titanic iron ores. One of the conclusions to which he arrives is, that they are compounds in different proportions of titanate of protoxyd of iron (FeO, TiO^2) with Fe^2O^3, in which part of the FeO is often replaced by magnesia (MgO). The proportions of the two members in different varieties are mentioned, but the numbers given are in general only approximate results from the analyses.

The great dominant fact in the titanic irons is their isomorphism with hematite, Fe^2O^3, and if we adopt Laurent's view of the constitution of such compounds, instead of looking for a titanate and sesquioxyd com-

bined, all the twelve varieties, with two or three exceptions, come very closely under the general formula M^2O^3,—M standing for all the metals (iron, titanium, manganese and magnesium) present. The following table shows that the coincidence for the varieties analyzed is quite remarkable —all but three or four giving almost exactly the ratio 1 : 1·5=2 : 3.

	M	O	Ratio.
Var. 1.	21·77	32·11	=1 : 1·48
" 2.	22·71	54·64	=1 : 1·52
" 3.	20·67	31·55	=1 : 1·50
" 4.	20·09	32·11	=1 : 1·60
" 5.	20·58	31·48	=1 : 1·53
" 6A.	21·17	31·67	=1 : 1·50
" 6B.	20·62	31·64	=1 : 1·54
Var. 7.	20·52	30 80	=1 : 1·50
" 8.	20·29	30·62	=1 : 1·51
" 9.	20·14	30·29	=1 : 1·50
" 10.	20·07	30·14	=1 : 1·50
" 11.	20·23	30·44	=1 : 1·50
" 12.	20·13	30·22	=1 : 1·50

The formula M^2O^3 appears to express the true nature of the compound.

2. *Kaba-Delreczin Meteorite.*—On the 15th of April, 1857, at 10^h P. M., a meteorite fell near Kaba in the vicinity of Delreczin in Hungary, and is now in a public Cabinet at that place. It is named the Kaba-Delreczin meteorite. Its weight before being broken was 7 pounds; but is now reduced to 5¼ pounds. It has not been analyzed.

3. *Ohaba Meteorite.*—On the 10th of October, 1857, some time after midnight there was a fall of a meteorite in the commune of Ohaba, east of Carlsburg. It is pyramidal in form, 14½ inches in height, and weighs 29 pounds. Specific gravity according to Dr. Grailich, 3·1103. It contains, according to Dr. Birkeisen:

Insoluble silicate (olivine),	44·83
Soluble silicate (augite and a feldspar),	18·27
Nickeliferous iron (Fe 21·40, Ni 1·80),	23·76
Sulphuret of iron,	13·14
	100·00

The specimen is in the Hof. Mineral Cabinet of Vienna.

4. *Geological Explorations in Kansas Territory;* by F. B. Meek and F. V. Hayden, (Proc. Acad. Nat. Sci. Philad., Jan. 1859).—This paper gives the results of the most extensive explorations of the Kansas rocks that have yet been made. They were undertaken last summer by Messrs. Meek and Hayden, and were carried forward with their well-known care and ability. The paper includes details respecting the Permian and Carboniferous rocks, their order of succession and characteristic fossils, and closes with descriptions of a considerable number of species. We cite a few pages giving a general section of the series, with their remarks upon the strata.

"As our examinations along the Kansas and Smoky Hill rivers above this point were made in more detail, where the outcrops were more frequent and continuous, we have, as we believe, been able to trace out the connections and order of succession of the various strata with considerable accuracy. Hence, we give below a general section of the rocks in this region, commencing with the Cretaceous sandstones on the summits of the Smoky Hills, lat. 38° 30′ N., long. 98° W., and descending through the various intermediate formations seen along the Smoky Hill and Kansas rivers, to the base of the bluff already mentioned, opposite the mouth of Big Blue river, on the Kansas. It is true, there are a few gaps in this section, where we were unable to see the beds along some of the slopes, but as we know the position in the series, as well as the extent of these gaps, it will be easy to determine, when a greater number of exposures have been examined, the nature of the beds occupying them.

General section of the Rocks of Kansas Valley from the Cretaceous down, so as to include portions of the upper Coal measures.

Feet.

1. Red, brown, and yellowish, rather coarse-grained sandstone, often obliquely laminated, and containing many ferruginous concretions; also, fossil wood and many leaves of dicotyledonous trees, some of which belong to existing genera, and others to genera peculiar to the Cretaceous epoch. *Locality, summit of Smoky Hills*..... 60

2. Whitish, very fine grained argillaceous sandstone, underlaid by bluish purple and ash colored clays. *Locality same as preceding*..... 15

3. Long, gentle slope, with occasional outcrops of ash-colored red, blue, and whitish, more or less laminated clays, with thin beds of sandstone. *Locality same as preceding, and extending down at places nearly or quite to the bluffs of Smoky Hill river;* thickness about..... 200

4. Red sandstone, with some layers of hard, light gray calcareous, do., and both containing ferruginous concretions. *Locality, bluffs Smoky Hill river, five or six miles above Grand Saline river.* Probably local, thickness seen about.. 15

5. Bluish, red, light yellow, and gray clays, and soft claystones, with sometimes a few thin layers of magnesian limestone. In many places these clays have been traversed in every direction by cracks, into which calcareous and argillaceous matter have found their way, and subsequently become consolidated so as to form thin seams of impure yellowish limestone, which cross and intersect each other at every angle. The red clays are usually less distinctly laminated, contain more arenaceous matter, and often show ripple marks on the surfaces. *Locality, bluffs along Smoky Hill river, above the mouth of the Grand Saline*..... 60

6. Light gray, ash-colored, and red clays, sometimes arenaceous, and often traversed by cracks, filled with calcareous matter as in the bed above,—alternating with thin layers and seams of gypsum. *Locality, near mouth of Smoky Hill river*..... 40

7. Rather compact amorphous white gypsum, with near the base disseminated crystals, dark colored do. *Locality same as last*.....4½ to 5

8. Alternations of ash-colored, more or less arenaceous clays, with thin beds and seams of gypsum above; towards lower part, thin layers of claystone, and at some places soft magnesian limestone. *Locality same as last*..... 50

9. Rough conglomerated mass, composed of fragments magnesian limestone and sandstone, with sometimes a few quartz pebbles, cemented by calcareous and arenaceous matter; variable in the thickness and probably local. *Locality, south side of Smoky Hill river, ten or twelve miles below Solomon's Fork*...seen 18

10. Bluish, light gray, and red laminated clays, with seams and beds of yellowish magnesian limestone, containing *Monotis Hawni, Myalina perattenuata, Pleurophorus? subcuneatus, Edmondia? Calhouni, Pecten* undet., and *Spirigera* near *S. subtilita;* also *Nautilus eccentricus, Bakevellia parva, Leda subacitula, Azinus rotundatus,* and undetermined species of *Bellerophon, Murchisonia, &c. Locality, near Smoky Hill river, on high country south of Fort Riley, as well as on Cottonwood creek*..... 90

11. Light grayish and yellow magnesian limestone, in layers and beds sometimes alternating with bluish and other colored clays, and containing *Solemya,* a *Myalina* near *M. squamosa, Pleurophorus? subcuneatus, Bakevellia parva, Pecten* undt., and a *Euomphalus* near *E. rugosus;* also, a *Spirigera* allied to *S. subtilita,* but more gibbous, *Orthisina umbraculum? O. Shumardiana, &c. Locality, summit of the hills, near Fort Riley and above there; also seen on Cottonwood creek*.....25 to 35

12. Light grayish yellow, rather granular magnesian limestone, containing spines and plates of *Archæocidaris;* a few fragments of small *Crinoid* columns, *Spirifer* similar to *S. lineatus,* but perhaps distinct; also same *Spirigera* seen in beds above, *Orthisina Shumardiana, O. umbraculum?* and *Productus Calhounianus. Forms distinct horizon near summit of hills in vicinity of Fort Riley, also seen on Cottonwood creek*.....7 to 8

13. Soft argillo-calcareous beds, apparently local. *Kansas Falls*..... 5

Feet.

14. Light grayish and yellowish magnesian limestone, containing many concretions of flint, also the same *Spirigera* found in beds above, and *Productus Norwoodi, P. Calhounianus*, with *Discina tenuilineata*, and an undetermined *Monotis. Fort Riley and below; also at Kansas Falls and on Cottonwood creek.* 38

15. Alternations, bluish, yellowish and brown clays, with a few thin seams of limestone. *Fort Riley, Kansas Falls; also below Fort Riley, and on Cottonwood creek* 35

16. Light yellowish magnesian limestone, containing *fucoidal* markings, fragments of small *Crinoid* columns, *Pecten, Allorisma, Spirigera, Orthisina umbraculum? O. Shumardiana, Discina tenuilineata, &c. Lower quarry at Fort Riley, and at other places above and below Fort R., as well as on Cottonwood creek.* ..... 4 to

17. Alternations of blue, red, and light gray clays, with sometimes thin layers and seams of magnesian limestone. *Fort Riley* 28

18. Light gray and whitish magnesian limestone containing *Spirigera, Orthisina umbraculum? O. Shumardiana, Productus Calhounianus, Acanthocladia Americana*, and undt. *sp. Cyathocrinus.* Lower part containing many concretions of flint. *Fort Riley and on Cottonwood creek.* Whole thickness about.. 40

19. Brown, green, and very light gray clays, alternating; contains near the upper part fragments of *Crinoid* columns, *Synocladia biserialis, spirigera, Productus Norwoodi, Chonetes mucronata, Orthisina Shumardiana, Orthisina umbraculum, &c.*, with teeth of *Petalodus Alleghaniensis. Fort Riley* 14

20. Alternations of rather thin layers light yellowish magnesian limestone, and various colored clays; the limestone layers containing *Monotis, Synocladia biserialis, &c. Locality same as last* 33

21. Slope, no rocks seen. *Below Fort Riley* 25

22. Whitish, or very light gray magnesian limestone, rendered porous by cavities left by the weathering out of numerous *Fusulina.* This is the highest horizon at which any remains of *Fusulina* were met with. *Some four miles below Fort Riley, along a creek on the south side of the Kansas, and apparently not more than ten feet above it* 2

23. Bluish, light gray, and brown clays, with occasional layers of magnesian limestone. *Chonetes mucronata, Orthisina umbraculum? Monotis, Fusulina, &c. Ten miles below Fort Riley* 35

24. Hard, very light yellowish gray magnesian limestone, with *Fusulina*, and spines of *Archæocidaris.* Forms a marked horizon near the *same locality as last.* 8

25. Slope, with occasional exposures, thin layers of *Fusulina* limestone, and seams of gray limestone containing *Myalina, Monotis, Pecten*, and fragments of *Synocladia biserialis. Near same locality as last* 36

26. Light gray argillaceous limestone, showing on weathered surfaces a somewhat laminated structure; contains large spines of *Archæocidaris. Near Ogden Ferry, and Manhattan* 9

27. Gray limestone, often fragmentary, with much clay above; lower part hard, and more or less cellular in middle. *Locality, same as last* 5

28. Whitish clays and claystones, with a thin layer of hard compact gray limestone near the middle. *Locality same as last* 10

29. Light greenish indurated clays. *Same locality* 3

30. Hard, heavy bedded, white argillaceous limestone, containing *Monotis* and *Avicula. Ogden Ferry, and below there* 5

31. Very thinly laminated dark green shale. *Three miles nearly east of Ogden Ferry, on McDowell's creek; also at Manhattan, on the Kansas* 1

32. Light greenish and flesh-colored hard argillaceous limestone, with *Spirifer cameratus.* This is the highest horizon at which we found this species. *Same localities* 3

33. Alternations of bluish, green and red more or less calcareous laminated clays, light gray limestones and claystones, with *Pecten, Monotis*, and fragments of *Crinoid* columns. *Same localities* 30

34. Alternations bluish, purple, and ash colored calcareous clays, passing at places into claystones, and containing in a thin bed near the middle, *Spirifer planoconvexa, Spirigera subtilita, Productus splendens? Rhynchonella Uta, &c. Locality same as preceding* 12

Feet.

35. Blue, light gray, and greenish clays, with occasional harder seams and layers of claystone and limestone. *Same locality*..... 33

36. Somewhat laminated claystone of light gray color, with more or less calc spar near lower part. *Manhattan*..... 19

37. Alternations of dark gray and blue, soft decomposing argillaceous limestone, with dark laminated clays, or soft shale, containing great quantities of *Fusulina cylindrica*, *F. cylindrica* var. *ventricosa*, *Discina Manhattanensis*, *Chætetes*, and fragments *Crinoids;* also, *Chonetes Verneuiliana*, *C. mucronata*, *Productus splendens? Retzia Mormonii*, *Rhynchonella Uta*, *Spirigera subtilita*, *Spirifer cameratus*, *S. planoconvexus*, *Euomphalus* near *E. rugosus*, and *Synocladia biserialis;* also *Cladodus occidentalis*. *Locality, same as last*..... 18

38. Soft bluish shale, with yellow laminated arenaceous seams below, containing fucoidal markings. *Same locality*..... 25

39. Two layers gray argillo-calcareous rock, separated by two feet of dark green and ash-colored clays. The calcareous beds contain fragments of *Crinoids*, *Chonetes*, and *Myalina* in undt. species. *Same locality as last*..... 4½

40. Light greenish, yellow, and gray clays and claystones, extending down nearly to high water mark of the Kansas, *opposite the mouth of Blue River*... 27

The foregoing general section of the strata seen along the valley of Kansas and Smoky Hill rivers, from the mouth of Blue river to the 98th degree of west longitude, is presented in its present form more with a view of illustrating the vertical range of the organic remains found in these rocks, than as an attempt to group the beds into formations that may be expected to preserve their distinctive lithological characters throughout areas of any great extent. As this has necessarily been done from a knowledge of only a portion of the fossils characterizing these strata, it is quite probable, when more extensive collections are obtained, that it may be found necessary even on this principle, to classify and group the beds somewhat differently. We are also aware that some of these beds probably increase or diminish greatly in thickness, or may even entirely thin out, at no very great distances from the localities where we saw them. * * *

It will be observed we have in this general section, without attempting to draw lines between the systems or great primary divisions, presented in regular succession the various beds with the fossils found in each, from the Cretaceous sandstone on the summits of the Smoky Hills, down through several hundred feet of intermediate doubtful strata, so as to include the beds containing Permian types of fossils, and a considerable thickness of rocks in which we find great numbers of upper coal-measure forms. We have preferred te give the section in this form because, in the first place, the upper coal measures of this region pass by so imperceptible gradations into the Permian above, that it is very difficult to determine, with our present information, at what particular horizon we should draw the line between them, while on the other hand, it is equally difficult to define the limits between the Permian and beds above, in which we found no fossils.

Beginning near the base of this section, we find we have in great numbers the following well known and widely distributed coal-measure fossils, viz., *Fusulina cylindrica*,* *Chonetes Verneuiliana*, *Productus splen-*

* In Russia, *Fusulina cylindrica* is said to occur only in the upper part of the lower Carboniferous series; but the fossil generally referred to that species in this country, appears to be confined to the coal measures. We have some doubts in regard to the identity with the Russian species.

dens, (or a closely allied species,) *Retzia Mormonii*, *Rhynchonella Uta*, *Spirigera subtilita*, *Spirifer cameratus*, *S. planoconvexus*, and a *Euomphalus* similar to *E. rugosus* of the coal measures, while the few new and undetermined species associated with these, are, for the most part, also decidedly more nearly allied to Carboniferous than Permian forms. We should here remark, however, that we occasionally met with a species of *Monotis*, allied to the Permian species *M. speluncaria* and *Synocladia biserialis*, (also regarded in the old world as a Permian genus,) at horizons far beneath the base of this section, between Manhattan and the Missouri. We even found a single specimen of this *Monotis* as low down as bed No. 9, of the section taken near the landing at Leavenworth City, which must occupy a position several hundred feet below the lowest beds of the above section. Still as this shell is very rare in the lower rocks, and the *Synocladia* is a distinct species from the well known Permian form of the old world, while they are both, at these horizons, associated with great numbers of the common well-known coal-measure species, we can only regard their presence in these beds as establishing the existence of these genera at an earlier period in this country, than in the old world. This, it seems to us, is more philosophical than it would be to place all this great thickness of strata, with their vast numbers of well known coal-measure species, in the Permian, merely because we also find with these occasionally a few forms which would in the old world be regarded as characteristic of the Permian epoch.

Taking it for granted then, that we have carried this section down far enough to include, not only all the beds containing almost exclusively Permian forms, but a considerable portion of the upper coal measures, it will be interesting to notice, as we ascend in the series, how far each of the coal-measure species mentioned in the lower part of the section, as well as of a few others that occur above and below, range upwards. Thus we see that *Fusulina cylindrica* var. *ventricosa*, *Chonetes Verneuiliana*, and *Retzia Mormonii* were not met with above division No. 37; while *Spirifer planoconvexus*, *Productus splendens?* and *Rhynchonella Uta*, were not observed above 34, nor *Spirifer cameratus* above 32. *Fusulina cylindrica*, of the slender variety so common in the coal measures of Kansas and Missouri, was not seen above 22; nor was any species or variety of that genus observed above this horizon.

Apparently the same species of *Monotis*, mentioned at various horizons far beneath, were occasionally met with in 30, 25, 23, and 20, generally associated with the same species of *Synocladia*, ranging far down into the upper coal measures. In division No. 19, we again met with the *Synocladia biserialis*, and a *Spirigera* allied to *S. subtilita*, if not identical, along with a new species of *Chonetes* we have called *C. mucronata*, which ranges down into the beds near the base of the section. Along with these were also *Productus Norwoodi* and *Orthisina Shumardiana*, both of which are common in the coal measures far below, and a large *Orthisina* similar to *O. umbraculum*, but apparently more finely striate.

Ascending through the intermediate beds to No. 12, we continue to meet with nearly all the species mentioned in 19, with the exception of *Chonetes mucronata*. We also have, first in 18, a large species of *Pro-*

ductus called *P. Calhounianus* by Professor Swallow; very similar to some varieties of *P. semireticulatus*, but thought by Prof. S., to present well marked internal differences. There is likewise added in 16, a large *Allorisma* and a *Spiriger* similar to *S. subtilita*, but much more gibbous; and in 14, *Discinia tenuilineatus* together with apparently the same *Monotis*, so often mentioned below. In 12, we also have added a small *Spirifer* similar to *S. lineatus*, but perhaps more nearly allied to the Permian species *Martinia Clannyana*, King.

The succeeding bed above, No. 11, appears also to contain a mingling of Permian with coal-measure forms, for we have in it the following Permian types, viz., *Myalina* very similar to *M. squamosa*, *Pleurophorus? subcuneatus*, *Bakevellia parva* and *Monotis Hawni*, along with a *Euomphalus* near *E. rugosus*, the same gibbous *Spirigera*, similar to *S. subtilita*, *Orthisina umbraculum?* and *O. Shumardiana*.

On passing into the next division above, No. 10, we find we have lost sight of all the characteristic Carboniferous forms, unless the *Spirigera* mentioned in some of the beds below be regarded as only a variety of *S. subtilita*, from which however, we think it specifically distinct; for with this exception, nearly all the fossils seen by us in this division, are such as would be regarded as Permian types. Although the number of *species* found by us in No. 10 is not great, *individual* specimens are often numerous. Above this horizon we saw no more fossils through a great thickness of various colored clays, claystones, &c., until ascending to the Cretaceous sandstones crowning Smoky Hills.

If we do not admit the existence in this region of an intermediate group of rocks, connecting by slight gradations the Permian above, with the coal measures below, and must draw a line somewhere, below which all is to be regarded as Carboniferous, and all above as Permian, we should certainly, upon palæontological principles alone, carry this line up as far as the top of division No. 11. The passage from the Carboniferous to the strata containing Permian types, however, is so gradual here, that it seems to us no one, undertaking to classify these rocks without any knowledge of the classification adopted in the old world, would have separated them into distinct *systems*, either upon lithological or palæontological grounds, especially as they are not, so far as our knowledge extends, separated by any discordance of stratification, or other physical break.* Indeed the fact that some of the Permian types occurring in No. 10, were first introduced in beds below this, containing many Carboniferous species, would seem to indicate that even No. 10 may possibly have been deposited just before the close of a period of transition from the conditions of the Carboniferous, to those of the Permian epoch.

"The apparent absence of fossils in the beds above No. 10, renders it impossible, with our present information, to determine with certainty the upper limits of the series containing Permian forms. It is true, there is

* We have been informed by Dr. J. G. Norwood, former State Geologist of Illinois, that the rocks in that State, referred by him and others to the same epoch as the Kansas Permian beds, rest unconformably upon the Coal measures. This, however, would be impossible in Kansas, since no disturbance of the strata occurred there, until after the close of the Cretaceous era, which would of course, not only cause the Cretaceous and Carboniferous, but all the intermediate beds, to dip at the same angle.

at places a kind of conglomerated mass, occupying the horizon No. 9, which might appear to form a natural line of division between the beds containing the Permian fossils, and those above, in which we found no organic remains; but this seems to be local, and although there is a new feature presented by the zone of gypsum deposits above it, we find between the beds and layers of gypsum, and far above the horizon at which they occur, bluish, greenish, and other colored clays, not only similar to those between the beds and layers of limestone containing the Permian fossils in division No. 10, but also precisely like the laminated clays between the beds of limestone of the upper Carboniferous series far below. Again, in these clays of the gypsum zone, as well as through a considerable thickness of clays above it, there are occasional seams of claystone, which sometimes pass into seams of magnesian limestone, exactly like some of those containing Permian fossils, in division No. 10. We saw no fossils in these seams amongst the gypsum-bearing beds, nor higher in the series, but it is probable they may yet be found in some of the more calcareous portions.

Another fact apparently indicating some kind of relation between the gypsum-bearing beds, as well as some of the higher deposits, and the rocks below, is, that we often find both in the clays between the beds of gypsum, and those between the limestone containing the Permian fossils, the same peculiar appearance caused by the cracking of the clays and subsequent infiltration of calcareous matter, seen in division No. 5. At some places the thin plates of limestone formed by the impure calcareous matter filling these cracks, may be seen ramifying through some rather thin beds of these clays in all directions, so as to cross and intersect each other at every angle. Where beds of this kind have been exposed for any length of time along near the tops of bluffs, the softer clays filling the interstices, often weather out, so as to leave a curious cellular mass, with the numerous angular cavities.

From these facts we are inclined to suspect,—though we are fully aware that it is a question which can only be determined upon evidence derived from organic remains,—that not only the gypsum-bearing deposits, but a large portion, if not all, of division No. 5, belongs to the same epoch as the beds containing the Permian fossils below.

Between No. 5 and the Cretaceous above, there is still a rather extensive series of beds in which we found no organic remains; these may be Jurassic or Triassic, or both, though as we have elsewhere suggested, we rather incline to the opinion that they may prove to belong to the former. As we have fully discussed the question in regard to the Cretaceous age of the highest division of the foregoing section in a paper read before the Academy in December last, and in an article in the American Journal of Science, January, 1859, it is unnecessary for us to add anything further on that subject here.

As already stated, our observations along the Kansas valley, to within twelve or fourteen miles of the mouth of Big Blue river, were too isolated to determine in all cases the relations between outcrops seen at different places. Consequently, although we saw at several points along this part of the valley, indications of a westward or northwestward inclination of the strata, we were left in some doubt whether or not there is

a general inclination of the rocks in that direction, between Wabounse and the Missouri. Above this point, however, our observations being more connected, and the exposures more continuous, we were able to determine very satisfactorily that there is at least from near Wabounse, a uniform dip towards the west or northwest, so that in ascending the Kansas valley from this region, we are constantly meeting with more and more modern rocks, as those we leave behind pass beneath the level of Kansas. * * * *

From the foregoing statements it will be seen that in consequence of the dip of the strata to the northwest, and in some slight degree to the fall of the Kansas and Smoky Hill rivers, the whole of the foregoing general section below No. 12 passes beneath the level of the Smoky Hill, between the mouth of Blue river and Chapman's Creek. Consequently, the limestones of the succeeding beds above being thinner and less durable than those below, and separated by heavy beds of clay; we find, as might be expected, that the country here in the region of the mouth of Chapman's Creek, is much lower than at Fort Riley and below.

On reaching the mouth of Solomon's Fork, we found the face of the country characterized by long gentle grassy slopes, no part of it near the river apparently being elevated more than about 60 or 70 feet above its surface. A short distance beyond this, we caught the first glimpse of the Smoky Hills, which were seen in a direction a little south of west from us, rising above the surrounding low country like dark blue clouds above the horizon. On approaching these, we found them always situated several miles back from the river, and rising some three hundred and fifty feet above it. The immediate bluffs of the river here, are generally composed of divisions No. 4 and 5 of the foregoing general section, and that portion of these hills above the level of the summits of the bluffs along the river, is made up of division Nos. 3, 2, 1, of the same section. On the south side of the river these hills have but a comparatively thin capping of the sandstone No. 1, but on the north side we saw it showing a thickening on some of them of sixty feet.

From some of these hills on the north side of Smoky Hill river, between it and the Grand Saline, we had an extensive and beautiful view of the surrounding country. In the north and northwest, many similar hills were in sight, and as the dip of the strata here is in that direction, it is probable that some of this are not only chiefly made up of the sandstone No. 1, but surmounted by the other Cretaceous beds Nos. 2 and 3 of the Nebraska Cretaceous series; indeed, Dr. Engelmann found all these formations occupying this relation on Republican river, not more than seventy miles north of this.*

Although this paper is merely designed to give a brief sketch of the leading geological features of these portions of northeastern Kansas visited by us, we cannot close it without alluding to the truly great agricultural and other natural resources of this new and interesting territory. We mean no disparagement to other portions of the Mississippi valley, when we state, that after having travelled extensively in the Great West, and after having seen many of its most favored spots, we have met with no country combining more attractive features than Kansas Territory. Her

* See Report of Secretary of War, Dec. 5th, 1857, page 497.

geographical position gives her a comparatively mild and genial climate, intermediate between the extremes of heat and cold, while the rich virgin soil of her beautiful prairies is admirably adapted to the growth of all the great staple grain and root crops of the west.

It is true that in some districts there is rather a deficiency of timber, but as a general thing there is along the streams sufficient for the immediate wants of the country. In addition to this, the wonderful rapidity with which forests are known to have sprung up on similar prairie lands in Missouri, as the country became settled so as to keep out the annual fires, shows that the present scarcity of timber should not be regarded as presenting any serious obstable to the settlement of the most extensive prairie district in Kansas.

Before going out into the interior of the Territory, we had expected to find the whole country immediately west of Fort Riley comparatively sterile; on the contrary, however, we were agreeably disappointed at meeting with scarcely any indications of decreasing fertility as far as our travels extended, which was about sixty miles west of Fort Riley. Here we found the prairies clothed with a luxuriant growth of grass, and literally alive with vast herds of buffalo that were seen quietly grazing as far as the eye could reach in every direction. Even on the high divide between the Smoky Hill and Arkansas rivers, south of this, we found the soil rich and supporting a dense growth of grass; and from all we could learn from persons who have gone further out, the same kind of country extends for a long distance beyond this, towards the west. Hence we infer that the belt of unproductive lands between the rich country on the east, and the eastern base of the Rocky Mountains on the west, is much narrower than is generally supposed; and even this so-called desert country is known to possess a good soil, which may be rendered fruitful by artificial irrigation.

In regard to the mineral resources of Kansas, we have at present only time and space to say a few words. As already stated, coal is known to exist, though its extent is not yet fully determined, at several localities in the region of Leavenworth City, while the geological structure of the country, as well as discoveries already made, warrant the conclusion that this important and useful mineral abounds at many localities south of there. Limestone suitable for building purposes, and the production of quicklime, exist throughout large areas, while inexhaustible beds of gypsum are known to occur at several places not far west of the mouth of Solomon's river. Near this place we likewise saw in the lower Cretaceous rocks crowning the summits of the Smoky Hills, deposits of iron ore, but were unable to determine in the limited time at our command, whether or not it exists in large quantities."

5. *On the Tertiary Flora of the vicinity of Vienna;* by Dr. C. von ETTINGSHAUSEN, (Abhandl. der k. k. Geol. Reichs. Wien, vol. ii).—This paper contains descriptions of 33 species which are illustrated by figures on five 4to plates. The principal conclusions from the facts are these:

The Flora belongs to the Miocene period. It is closely analogous to that of the Miocene deposits of Upper Styria at Parschlug and Fohnsdorf, Leoben, etc. It is also near that of Swoszowice in Galicia, and has some relations to that of Bilin in Bohemia, and of Œningen, and St. Gallen in Switzerland.

Among the species 1 of them has a representative in Central Europe, 4 in Southern Europe, 2 in Central Asia, 10 in North America, 2 in South America, 6 in the East Indies, and 2 in Australia.

The Climate indicated is subtropical or from 15° *to* 21° *R.*

The especially tropical species are *Artocarpidium cecropiæfolium, Daphnogene polymorpha, Cissus platanifolia, Sterculia Vindobonensis, Pterospermum dubium, Cupanodes miocenicus.* = 6.

The subtropical are *Laurus Swoszowiciana, Hakea pseudo-nitida, Dryandra Vindobonensis* (the last two Australian in type), *Bumelia ambigua, Diospyros pannonica, Andromedites paradoxus, Rhamnus Augustinii, Myrtus Austriaca, Leguminosites macharioides, L. ingæfolius, Cassia ambigua.* = 11.

The warm temperate species are *Cyperites tertiarius, Potamogeton Ungeri, Pinites Partschii, Betula prisca, B. Brongniartii, Alnus Kefersteinii, Fagus castaneæfolia, Quercus Haidingeri, Planera Ungeri, Liquidambar europæum, Styrax pristinum, Acer pseudocreticum, Pterocarya Haidingeri.* = 13.

The species particularly North American in type are *Fagus castaneæfolia, Quercus Haidingeri, Liquidambar europæum, Laurus Swoszowiciana, Bumelia ambigua, Diospyros pannonica, Andromedites paradoxus.*

These beds contain *Hippotherium gracile* Kaup, among remains of Mammals; *Cybium Partschii* Münst., among Fishes; *Melanopis Martiniana* Fér., *M. Bouei* Fér., *M. pygmæa* Partsch, *Cardium apertum* Munst., *C. plicatum* Eichw., *Congeria subglobosa* Partsch., *C. spathulata* Partsch, among Molluscs; *Cytherina tenuis* Reuss among Crustacea.

6. *On the Tertiary Flora of Haring in the Tyrol;* by Dr. C. von Ettingshausen.—This paper is finely illustrated like the preceding. It describes 180 species.

The Flora is of the Eocene Period; of the same age with that of Sotzka in Upper Styria, Sagor in Krain, Monte Cromina in Dalmatia. 73 of the species have been described from other localities, and of these 41 are exclusively Eocene, 9 Miocene, and 23 common to Eocene and Miocene. Among the Miocene localities, that of Parschlug contains the largest number of the Haring species, namely 21; Oeningen contains 8, Bonn 7, Bilin 7, Vienna 3 and Heiligenkreuz near Kremnitz 2 identical species.

The Climate indicated by the plants is tropical or a mean temperature between 18 *and* 22° *R.*

There are several species of palms, and representatives of the families Moreæ, Artocarpeæ, Nyctagineæ, Monimiaceæ Laurineæ, Proteaceæ, Apocynaceæ, Bignoniaceæ, Sapotaceæ, Ericaceæ, Malpighiaceæ, Sapindaceæ, Euphorbiaceæ, Rhizophoreæ, Myrtaceæ, Papilionaceæ, Mimoseæ, etc.

The Flora has its closest analogies with that of Australia.—The Proteaceæ, Myrtaceæ, and Leguminoceæ constitute a third part of the flora. 55 species out of the whole are analogous to Australian types, 28 to East Indian, 23 to tropical America, 14 to South African, 8 to Pacific Island, 7 to North American and Mexican, 6 West Indian, 5 South European. The resemblance to Australia consists not merely in the number of the species, but also in the characters of the species—as the small oblong leathery leaves of the Proteaceæ and Myrtaceæ, the delicate branchlets of the Casuarinæ, the Cypress-like Australian species of *Frenela*

and *Callitris*, some peculiar species of Santalaceæ, Sapotaceæ, and Leguminosæ. This relation to Australian vegetation is also evident in the fossil flora of Sotzka. Only 11 species have their representatives in the warm temperate climates, namely, *Juniperites ecenica*, *Pinites Palæostrobus*, *Quercus deformis*, *Q. Goepperti*, *Alnites Reussii*, *Planera Ungeri*, *Salicites stenophyllos*, *Laurus Lalages*, *Ilex Oreadum*, *Rhamnus colubrinoides*, *Juglans hydrophila*.

7. *Fossil Flora of Köflach, near Gratz, in Styria.*—Dr. C. R. von Ettingshausen has described the plants of Köflach in the Jahrbuch der k. k. geol. Reichsanstalt of Vienna, 1857, p. 738. They are of the Miocene era. There are 34 species, 12 of which are new, and 15 common with the flora of Fohnsdorf in Styria. More of the species occur in the Miocene of Switzerland than in the fossil flora of Schauerleithen near Pitten in Lower Austria, and but very few of them are found in the Parschlug deposit. The most common species are the *Sequoia Langsdorfi* Heer, and *Alnus Kefersteinii* Goepp.; and next to these *Glyptostrobus Europæus* Heer, *Betula Brongniartii* Ettings., and *Carpinus Heerii*. Among the peculiar species there is a *Myrica Joannis* Ettings., near the *Myrica Caroliniana* of North America, *Verbenophyllum aculeatum* Ettings., *Dombeyopsis helicteroides* Ettings., a tropical American type, *Euonymus Haidingeri* Ett., *Zizyphus Daphnogenes*, *Ceanothus macrophyllus* Ett., also related to a North American type, *Euphorbiophyllum crassinerve* and *E. Stiriacum* Ett., analogues of tropical Euphorbiaceæ. The paper is illustrated by many excellent wood-cuts and three plates.

8. *On some deposits in Tuscany containing Fossil Leaves;* by C. T. Gaudin of Lausanne, and Marquis C. Strozzi of Florence.—According to a notice in the Jahresb. k. k. Geol. Reichs. 1858, p. 135, these Tuscan deposits are situated in the upper part of the valley of the Arno, at Montajone, Bozzone and Malmerenda. These and the Piedmont beds of Chieri, Guarena, Sarzanello and others, and those of Sinigaglia, are on nearly the same horizon with those of Parschlug, Tallya, Swoszowice, Gleichenberg, Schossnitz, and also the Swiss localities at Oeningen, Ischel, Schrotzburg, Albis, Locle and the upper freshwater mollasse, while of older tertiary (Eocene above the nummulitic beds), are the deposits of Cadibona, Bagnasco, Stella in Italy; Lausanne, Aarwangen, Moulin-Monod, Hohe-Rhonen, Eriz, Rochette, Rivaz, Ralligen, Wäggis, in Switzerland; and Häring, Sotzka, Monte Promina of Austria.

9. *Post-tertiary of the St. Lawrence Valley;* by J. W. Dawson, (Canadian Nat. and Geol., iv, 23).—This paper describes and figures a number of new species of Foraminifers and Bryozoans from the Canada Post-tertiary, besides giving details respecting two or three localities, mentioned in the former paper, (see this Journal, [2], xxv, 275, and Can. Nat. and Geol. ii, 401). The following paragraphs are cited from the memoir.

Section at *Logan's Farm:*

Soil and Sand, - - - - - - - - - -	1	9
Tough reddish clay, - - - - - - - - - -	0	0½
Gray sand, a few specimens of *Saxicava rugosa*, *Mytilus edulis*, *Tellina Grænlandica*, and *Mya arenaria*, the valves generally united, - - - - - - - - - -	0	8

Tough reddish clay, a few shells of *Astarte Laurentiana*, and *Leda Portlandica*, - - - - - - - - - -	1	1
Gray sand, containing detached valves of *Saxicava rugosa*, *Mya truncata*, and *Tellina Grœnlandica;* also *Trichotropis borealis*, and *Balanus crenatus:* the shells in three thin layers, - - - - - - - - - - - -	0	8
Sand and clay, with a few shells, principally *Saxicava* in detached valves, - - - - - - - - - - -	1	3
Band of sandy clay, full of *Natica clausa*, *Trichotropis borealis*, *Fusus tornatus*, *Buccinnum undatum*, *Astarte Laurentiana*, *Balanus crenatus*, &c. &c., sponges and *Foraminifera*. Nearly all the rare and deep-sea shells of this locality occur in this band, - - - - - - - - - -	0	3
Sand and clay, a few shells of *Astarte* and *Saxicava*, and remains of sea-weeds with *Lepralia* attached; also *Foraminifera*, - - - - - - - - - - -	2	0
Stony clay, boulder clay.		

It thus appears that at Logan's farm we have littoral species at top, and that all the rare and deep-water fossils, as well as the *Lepraliæ* and *Foraminifera* occur in a comparatively thin band near the base of the deposit. This corresponds precisely with the order observed elsewhere in the vicinity of Montreal; though at Logan's farm the arrangement is somewhat more complex than in other localities.

Beauport.—I visited this celebrated deposit for the first time last autumn. At first sight it consists of a mass of stratified sand and gravel, equivalent to the Saxicava sand of Montreal, and resting on boulder clay. The overlying mass is filled with *Saxicava*, *Tellinæ*, &c.; and the underlying boulder clay as usual contains no fossils. My experience in the Montreal deposits, however, led me to expect a bed, however thin, representing the Leda clay, between these; and on searching at the junction of the two great beds above mentioned, I was gratified by finding a layer of sand about three inches in thickness, filled with the rarer shells of the deposit, characteristic of its deeper waters, such as *Fusus tornatus*, *Pecten Islandicus*, *Buccinum ciliatum*, *Modiolaria discors*, &c.* The *Rhynconella psittacea* occurs only in this layer, and in such a manner as to leave no doubt that it is buried here in situ, in the very spot where it lay anchored to the stones of the surface of the drift. On these stones, however, I found a new and interesting field for observation. In the thin layer above referred to, all the stones, as well as those that lay on the surface of the boulder clay or partly imbedded in it, were covered with the remains of marine creatures, especially *Balanus crenatus*, *Spirorbis sinistrorsa*, *Spirorbis spirillum*, *Lepralia* and *Hippothoa*. This layer, in short, evidently represented a time when the surface of the boulder clay, covered only by a thin layer of sand and stones, constituted the bottom of clear and deep water, before it became covered by the Saxicava sand. This bottom, although no clay has been deposited on it, represents the Leda clay at Montreal, and is exceedingly rich in the fossils usually found

* Sir C. Lyell notices the fact that these shells are more abundant in the lower part of the mass than above.

at the surface of that bed. *Foraminifera* occur in it, but they are comparatively rare, and, so far as I could find, only of species common at Montreal.

The paper concludes as follows:

"In so far as general conclusions in geology are concerned, the observations of the past year do not in any way conflict with the conclusions stated in my former paper.

The arrangement of the deposits at Logan's farm and Beauport, confirms the subdivision which I have attempted to establish, of an underlying non-fossiliferous boulder clay, a deep-water bed of clay or sand (the Leda clay of Montreal), and overlying shallow-water sands and gravels, the Saxicava sand of my former paper. This arrangement shows a gradual upheaval of the land from its state of depression in the boulder-clay period, corresponding with what has been deduced from similar appearances in the Old World. 'The upheaval of the bed of the glacial sea,' says Forbes, 'was not sudden but gradual. The phenomena so well described by Prof. Forchhammer in his essays on the Danish drift, indicating a conversion of a muddy sea of some depth into one choked up with sand banks, are, though not universal, equally evident in the British Isles, especially in Ireland and the Isle of Man.'*

We now have in all, exclusive of doubtful forms, sixty-three species of Marine Invertebrates from the Post-Pliocene or Pleistocene clays of the St. Lawrence valley. All, except four or five species belonging to the older or deep-water part of the deposit, are known as living shells of the Arctic or Boreal regions of the Atlantic. About half of the species are fossil in the Pleistocene of Great Britain. A majority of the whole are now living in the Gulf of St. Lawrence and on the neighboring coasts; and I have reason to believe that the dredging operations carried on by the officers of the Geological Survey in the past summer, will enable us to recognize all but a few as living Canadian species. In so far, then, as marine life is concerned, the modern period in this country is connected with that of the boulder clay by an unbroken chain of animal existence. These deposits in Lower Canada afford no indications of the terrestrial fauna; but the remains of *Elephas Primigenius* in beds of similar age in Upper Canada,† show that during the period in question great changes occurred among the animals of the land; and we may hope to find similar evidences in Lower Canada, especially in localities where, as on the Ottawa, the debris of land-plants and land-shells occur in the marine deposits."

10. *Second Biennial Report on the Geology of Alabama;* by M. Tuomey, A.M., Geologist to the State, and Prof. Geol. and Nat. Hist. Univ. of Alabama; edited from the Author's MSS. and other papers by J. W. Mallet, Ph.D., Prof. Chem. Univ. of Alabama.—The death of Prof. Tuomey left the Geological Survey of Alabama, that had been in progress under his charge, unfinished, and the preparation of his Second Report incomplete. A large part of the MS. was given to the printers in 1856; but only one or two signatures had been printed before his decease in March, 1857. The manuscript, partly in confusion and partly lost through some carelessness on the part of the printer, was afterwards put into the hands of

* Memoirs of Geological Survey. † Reports of Geol. Survey; Lyell's Travels.

Prof. Mallet, the Chemist of the Survey, and under his direction the results have been brought out. The volume treats briefly of the geology of the northern part of the State, giving some facts relating to the Silurian, Devonian and Carboniferous rocks, and also the metamorphic, with particular descriptions of iron ores and other economical products. It also mentions local details on the newer deposits of the State. The important statement is here made that the "*Gnathodon* beds" of Mobile bay, regarded as fossil beds by Lyell, are beyond doubt accumulations made by the aborigines of the country. They are often in heaps and contain ashes, burnt shells and charcoal, and bear no evidence of accumulation by wave action. The Report of Prof. Mallet, as Chemist of the Survey, contains analyses of a large number of rocks and ores.

11. *The Earthquake Catalogue of the British Association*, with the Discussions, Curves and Maps, etc.; by ROBERT MALLET, C.E., F.R.S., and JOHN WILLIAM MALLET, Ph.D., Prof. Chem. University of Alabama. From the Transactions of the British Association for the Advancement of Science, 1852 to 1858: being Third and Fourth Reports. Lond. 1858. —This thick 8vo volume contains the papers of the authors on earthquakes contributed to the British Association at the meetings from 1852 to 1858; of their thoroughness and great value it is not necessary here to speak. The work is indispensable to all who would understand the subject in its details and full breadth. The paper of 1858 is now for the first time issued, as the Report of the Association for last year has not yet been distributed: and it has special interest as it reviews the "Facts and Theories of Earthquake phenomena," and is illustrated by several fine maps.

12. *Catalogue of Mineralogical, Geological and Palæontological Specimens, Collections, Models, etc., offered for sale at the Rheinische Mineralien-Comptoir of Dr. A. Krantz, at Bonn in Prussia.* American edition, 1859, pp. 48.—Collectors of mineral and geological specimens will be glad to know that Dr. Krantz has published an American edition of his Catalogue, and that it may be obtained gratis on application to Messrs. J. F. Luhme & Co., who have been appointed his sole agents for the United States. This Catalogue will serve an excellent purpose in guiding mineralogists and others as to the comparative value of mineral and geological specimens, and at the same time it gives an idea of the extended scale upon which Dr. Krantz conducts business in his justly celebrated establishment.

III. BOTANY AND ZOOLOGY.

1. *American Weeds and Useful Plants: being a second and illustrated edition of Agricultural Botany, &c.;* by WM. DARLINGTON, M.D. Revised, with additions, by GEORGE THURBER, Prof. of Mat. Med. and Bot. in N. Y. College of Pharmacy. New York: Moore & Co. 1859, pp. 460, 18mo.—Dr. Darlington's Agricultural Botany was always a favorite, and in its new dress it deserves to be still more so. While regretting that the author, at his advanced age, "felt indisposed to assume the labor of a revision," we are satisfied that, if the task must fall into younger hands, it could hardly fall into better ones than those of the present editor.

He has extended the limits of the work so as to include the commoner medicinal plants, and such of our native shrubs as are worthy of cultivation, and has added a brief, remarkably well written, and pertinent introductory chapter upon the Structure of Plants, followed by a key to the natural orders of the plants described in the volume. In a book so full of information about useful plants, it seems hardly fair to promote the term 'weeds' to the head of the title—by these meaning "those intrusive and unwelcome individuals that will persist in growing where they are not wanted." But, after all, so far as botany can help him, the farmer needs rather to be instructed how to dispose of his enemies than how to make the most of his friends. This edition is illustrated by good wood engravings of many of the plants described, in great part from original drawings from the skillful pencil of Mr. Anthony Hochstein. A. G.

2. *Journal of the Proceedings of the Linnæan Society* (Botany), No. 10, (1858); contains:—

Synopsis of Legnotideæ, by George Bentham. He still regards these plants as forming a mere "tribe of *Rhizophoraceæ*," and as having "a general affinity with *Cunoniaceæ* and with *Lythraceæ*," as Brown long ago suggested. Mr. Bentham distinguishes nine genera, one of which is new, and about twenty-one species. One of the most interesting of these is a new *Crossostylis*, detected (in fruit only) by Prof. Harvey in the Feejee Islands, having fewer carpels in its gynæcium than Forster's *C. biflora*, for the elucidation of which we are indebted to the South Pacific Exploring Expedition under Capt. Wilkes. Mr. Bentham also contributes a

Notice of the Rediscovery of the genus Asteranthos, Desf., by Mr. Spruce.—Although ticketed as from Brazil, this curious plant was suspected to be African, because *Napoleona*, its only relative is African; but Spruce has now confirmed its American origin by finding it, in great abundance, upon the banks of one of the tributaries of the Casiquiare. Mr. Bentham inclines to Lindley's view of the close affinity of these two plants with the *Myrtaceæ*.

Monograph of the Eucalypti of Tropical Australia, with an arrangement, for the use of Colonists, according to the Structure of the Bark; by Dr. Ferdinand Müller, Government Botanist, Victoria.—The zealous and indefatigable Dr. Müller here describes 38 species in great part from the region which he had assisted to explore in Gregory's expedition. The succeeding popular arrangement by the bark divides them into six primary sections, the Latin characters of which will need translation before they can well be used by the colonists.

On some Tuberiform Vegetable Productions from China; by the Rev. M. J. Berkeley.—One of these *Fungi* (if such these apparently structureless rounded bodies are), the *Pu-foo-ling* of the Chinese, known immemorially in the northern part of China, where it is largely used as a drug and an esculent—and which was also described by Lourciro—proves to be identical with the *Tuckahoe* or Indian-bread of the Atlantic United States (*Lycoperdon solidum*, of Gronovius in Clayton's Flora Virginica, *Sclerotium Cocos* of Schweinitz, *S. giganteum* of Torrey, the *Pachyma Cocos* of Fries); thus adding another to the long list of species peculiar or nearly so to China or Japan and to the eastern side of North America.

Mr. Berkeley states that Tuckahoe has been analyzed by Prof. Ellet, and "ascertained to consist entirely of pure pectine of Braconnot. It is quite insoluble in water, though it dissolves in alkaline solutions, forming neutral pectates, whence the pectic acid is separated by the addition of muriatic acid, in the form of a colorless jelly: ..... This jelly may be prepared so as to form an agreeable article for the dessert."

We have not at hand the Gardener's Chronicle for 1848, referred to by Mr. Berkeley, in which the late Professor Ellet's account is probably cited. But we will at once reclaim the discovery and the original publication of these particulars for Professor Torrey, who, we may say, discovered that Tuckahoe was composed of pectine before pectine was itself discovered by Braconnot. Prof. Torrey's original paper upon the subject was read before the Lyceum of Natural History, New York, in the year 1819, and was published in the N. Y. Medical Repository for December, 1820; in this, after chemically ascertaining the properties of the substance, as since recognized, he adds that, "having shown that this principle differs from all those before described, it must be considered as a new species, and may be called *Sclerotin*." In 1827, after the publication of Braconnot's paper upon pectic acid, Dr. Torrey republished his earlier paper, with some additions, in the New York Medical and Physical Journal (vol vi, No. 4), and showed the identity of the two substances. Moreover, he criticised,—it is still thought with good reason,—the characters assigned by Braconnot to pectic acid, being unable to detect any acid properties in the Tuckahoe itself, and attributing the acid reaction of the so-called pectic acid, as prepared, to some of the muriatic acid employed for coagulating the solution being entangled in the jelly so completely that it could not be removed by the most copious washing, even with alkali. And Braconnot's so-called salts of pectic acid were suspected to be mere mixtures of the sclerotin with the alkali employed to dissolve it, and entangled in the substance when the jelly was formed. Inasmuch as Prof. Torrey's experiments and publications were perfectly well known to the late Prof. Ellet, it seems probable that they were duly referred to in his own publication. If not, they certainly should have been.

Notes on Abuta, a genus of Menispermeæ; by Prof. Grisebach of Gottingen; correcting its characters and limitation, and reducing to it *Anelasma* of Miers.

Notes on Arctic Plants, by Prof. Dickie of Belfast.

No. 11, issued early in the present year, contains several articles; of which much the longest and most important is Dr. F. Müller's paper on *Australian Acaciæ*, with annotations by Mr. Bentham. A note on the *Morphology of the Balsaminaceæ*, by Prof. Henfrey, promises no small interest, but the present number closes with its mere commencement.

A. G.

3. Walpers, *Annales Bot. Systematicæ;* continued by Dr. C. Mueller.—Vol. IV, the first of the continuation, closes with the *Begoniaceæ*, —a full abstract of Klotzsch's well-known memoir. These details were the less needed, inasmuch as the order is now printing in DeCandolle's Prodromus. The first fasciculus of the fifth volume, issued at the close of the past year, carries on the work from the *Passifloreæ* to the Eupatorineous *Compositæ*. This is a very useful compilation, but not remarkably

well planned. The bare index to the 215 species of *Mesembryanthemum* figured by Salm-Dyck is contrived so as to occupy rather more than four pages. A. G.

4. *On Parthenogenesis;* by E. REGEL, (Bot. Zeitung, Oct. 8, 1858, and a translation by Henfrey in Ann. and Mag. Nat. Hist., Feb. 1859).—Mr. Regel stoutly denies vegetable parthenogenesis altogether; but some of his objections are those of a special pleader rather than of an investigator, such especially as his remarks upon the case of *Cœlebogyne*. He records, however, some new observations upon *Spinacia* and *Mercurialis*, upon female plants of which, after strongly cutting them in, he finds male flowers constantly developed, which without great care would have escaped notice; whence he concludes that the results obtained by Naudin and Decaisne are valueless. He thinks he might find imperfect anthers upon female plants of *Cœlebogyne!* It is to be hoped that he will have the opportunity of searching for them; also that the French botanists will repeat his experiments upon *Mercurialis*, &c. But how does Regel reach the conclusion if an embryo may in certain cases be developed when fecundation is prevented then stamens are wholly superfluous structures? As, on the one hand, there is considerable reason to suspect that hermaphrodite plants continuously self-fecundated would after a while become sterile and so verge to extinction, so, on the other, sexual fecundation may be strictly necessary to the perpetuation of the species, without being strictly indispensable for every generation. And if there really be parthenogenesis in plants (and the evidence still seems to show that there is), then it is not likely to be restricted to two or three special cases, nor to dicœcious species; but it is probable that some of the seeds in ordinary fruits, especially in polyspermous ones, are sometimes perfected without fecundation. *Natura non facit saltum.* A. G.

5. *Notices sur l'Amelioration des Plantes par le Semis, et Considerations sur l'Hérédité dans les Vegetaux*, &c.; par M. LOUIS VILMORIN. Paris, 1859, 8vo pamphl., pp. 64.—This very interesting pamphlet is a collection and reprint of several of Louis Vilmorin's important communications to the Central Agricultural Society of France and to the Academy of Sciences; to which is prefixed a French translation of a memoir upon the Amelioration of the Wild Carrot, contributed by his venerable father to the Transactions of the London Horticultural Society (but not before published in the vernacular of the author), which memoir, as the younger Vilmorin informs us, was the point of departure for his own investigations in this field, and even contains the germ of most of the ideas which he has since developed upon the theory of the amelioration of plants from the seed. These papers claim the attention of the philosophical naturalist, no less than of the practical horticulturist.

Most of our esculent plants are deviations from the natural state of the species, which have arisen under the care and labor of man in very early times. New varieties of these cultivated races are originated almost every year, indeed; but between these particular varieties, the differences, however well marked, are not to be compared for importance with those changes which the wild plant has generally undergone, in assuming the esculent state. In this amelioration or alteration, as in other cases, *c'est la premiere pas que coûte.* For the altered race, once origin-

ated, has much less stability than the wild stock; it accordingly tends, not only to *degenerate* (as the cultivator would term it) towards its original and less useful state, but also to *sport* into new deviations, in various directions, with a freedom and facility not manifested by its wild ancestors. This explains the readiness with which we continually obtain new varieties of those esculent plants which have been a long time in cultivation, while a newly-introduced plant exhibits little flexibility. To detect the earliest indications of sporting, and to select for the parents of the new race those individuals which begin to vary in the requisite direction, is the part of the scientific cultivator. In this way, the elder Vilmorin succeeded in producing the esculent carrot from the wild stock in the course of three generations,—no addition to our resources, indeed, but significant of what may be done by art directed by science. By adopting and skillfully applying these principles, the younger Vilmorin has conferred a benefit upon France which (if she will continue to make sugar from the beet) may almost be compared with that of causing two blades of grass to grow where only one grew before, having, so to say, *created* a race of beets containing twice as much sugar as their ancestors, and indicated the practicability of its perpetuation. The mode of procedure, and the ingenious methods he contrived for rapidly selecting the most saccharine out of a whole crop of beets, as seed-bearers for the next season, are detailed in these papers.

Once originated, and established by selection and segregation for a few generations, the race becomes fixed and perpetuable in cultivation, with proper care against intermixture, in virtue of the most fundamental of organic laws, viz., that the offspring shall inherit the characteristics of the parent,—of which law that of the general permanence of species is one of the consequences. The desideratum in the production of a race is, how to initiate the deviation. The divellent force, or idiosyncracy, the source of that "infinite variety in unity which characterizes the works of the Creator,"—though ever active in all organisms, is commonly limited in its practical results to the production of those slighter differences which ensure that no two descendants of the same parent shall be just alike, being overborne by that opposite or centripetal force, whatever it be, of which ensures the particular resemblance of offspring to parents. Now the latter force, as Mr. Louis Vilmorin has well remarked, is really an aggregation of forces, composed of the individual attraction of a series of ancestors, which we may regard as the attraction of the type of the species, and which we perceive is generally all-powerful. There is also the attraction or influence of the immediate parent, less powerful than the aggregate of the ancestry, but more close, which ever tends to impress upon the offspring all the parental peculiarities. So, when the parent has no salient individual characteristics, both the longer and the shorter lines of force are parallel, and combine to produce the same result. But whenever the immediate parent deviates from the type its influence upon its offspring is no longer parallel with that of the ancestry; so the tendency of the offspring to vary no longer radiates around the type of the species as its centre, but around some point upon the line which represents the amount of its deviation from the type. Left to themselves, as Mr. Vilmorin proceeds to remark, such varieties mostly perish in the vast

number of individuals which annually disappear,—or else, we may add, are obliterated in the next generation through cross-fertilization by pollen of the surrounding individuals of the typical sort,—whence results the general fixity of species in Nature. But under man's protecting care they are preserved and multiplied, perhaps still further modified, and the better sorts fixed by selection and segregation.

Keeping these principles in view, Mr. Vilmorin concluded that, in order to obtain varieties of any particular sort, his first endeavor should be to elicit variation in any direction whatever; that is, he selected his seed simply from those individuals which differed most from the type of the species, however unlike the state it was desired to originate. Repeating this in the second, third and the succeeding generations, the resulting plants were found to have a tendency to vary widely, as was anticipated; being loosed, as it were, from the ancestral influence, which no longer acted upon a straight and continuous line, but upon one broken and interrupted by the opposing action of the immediate parents and grand parents. Thus confused, as it were, by the contrariety of its inherited tendencies, it is the more free to sport in various ways; and we have only to select those variations which manifest the qualities desired, as the progenitors of the new race, and to develope and fix the product by selection upon the same principle continued for several generations.

It is in this way that Mr. Vilmorin supposes cross-fertilization to operate in the production of new varieties; and even in the crossing of two distinct species, the result, he thinks, is rarely, if ever, the production of a fertile hybrid, but of an offspring which, thus powerfully impressed by the strange fertilization, and rendered productive by the pollen of its own female parent, is then most likely to give origin to a new race.

We cannot follow out this interesting but rather recondite subject in a brief article like this. But we are naturally led to enquire whether the history of those plants with which man has had most to do, and the study of the laws which regulate the production and perpetuation of domesticated races, may not throw some light upon the production of varieties in Nature; and whether races may not have naturally originated, occasionally, under circumstances equivalent to artificial selection and segregation. Some recent attempts which have been made in this direction we may hope to notice upon another occasion. A. G.

6. *Botanical Necrology for* 1858.—The list of botanists who have departed during the past year is a long one, and includes some most eminent names,—such as those of Brown and Bonpland, which have already been noticed in the pages of this Journal. The following are the principal:—

Dr. B. Biasoletto, of Trieste; died January 17, 1858, act. 65. He was a local botanist of merit, and an investigator of the *Algæ* of the Adriatic.

Aimé Bonpland, the well-known companion of Humboldt in American travel, and ever since a resident of Paraguay. Died in the 85th year of his age, August 22, 1857, but his decease was not announced in Europe until after the close of that year.

Robert Brown, of London, long since styled by Humboldt *Botanicorum facile princeps:* died May 10, 1858, in the 85th year of his age.

Prof. G. A. Eisengrein, of Freiburg in Briesgan; died July 26, 1858.

H. Galeotti; a scientific traveller and well-known botanical collector in Mexico and Central America; died in April, aet. 44.

W. T. Gumbel, of Landau, Rhenish Bavaria; a distinguished bryologist, associated with Schimper in the publication of the later portions of the *Bryologia Europæa:* died Feb. 10, 1858, aet. 46.

Mrs. Loudon, the widow of *J. C. Loudon*, herself an able popular writer of works upon gardening and botany, and a person of remarkable ability, whose name may well claim a place in this list: died, near London, in July, 1858.

Prof. Ernest H. F. Meyer, of Königsberg: died, August 7, at a mature age. His earliest work, a monograph of *Juncus*, was published in 1819.

Prof. C. F. A. Morren, of Louvain, died, Dec. 17, 1858; aet. 52. His writings mainly relate to physiological matters.

Dr. J. B. Mougeot, of Bruyères, in Eastern France, a cryptogamist of considerable note: died, Dec. 5, 1858, aet. 82 years.

Prof. C. G. Nees von Esenbeck, long one of the most distinguished and productive botanists of Germany, and for almost half a century President of the old Imperial Society Naturæ Curiosorum: died March 16: aet. 82 years.

David Townsend, of West Chester, Pennsylvania, the life-long associate of the venerable Dr. Darlington, who has published an interesting memorial of his friend and companion in botanical pursuits. Dr. Darlington and Mr. Townsend have made the quiet borough of West Chester famous in botanical annals, and have set an example worthy of all imitation. Although not, like his distinguished associate, a botanical author, Mr. Townsend was an excellent and active local botanist, and was so skillful and tasteful in the preparation of dried specimens that Sir William Hooker associated his name with that of Professor Short of Kentucky, as preëminent in this important art. Mr. Townsend's name is commemorated in the genus *Townsendia*, of Hooker, peculiar to North America, now comprising six of seven species of humble but beautiful, Aster-like plants. The botanist whose name they will perpetuate died, Dec. 6, 1858, at the age of 71 years.

Dawson Turner, Esq., of Yarmouth, one of the oldest of British botanists, who so early as the year 1802 published his first work upon the British Fuci, died on the 20th of June, 1858, at the age of 83 years.

C. Zeyher, whose name with that of Ecklon, is so intimately associated with the botany of the Cape of Good Hope, which he has so extensively explored, died at the Cape, near the close of the past year.

A. G.

7. *Mammoth Tree of California—Sequoia gigantea.* (From an article by Dr. B. Seemann, Ann. Mag. Nat. Hist., [3], iii, 175).—The mammoth tree was introduced into European gardens by Mr. William Lobb; and in 1853 single plants were sold by Veitch's Nursery for £2 2*s.*; but since then quantities of seeds have been imported, and there is now hardly a horticultural establishment without one or more representatives of this remarkable evergreen. In England it seems to stand the winter without injury; and even in Germany and other parts of Northern Europe it does not require the protection of a glass house; so that even

in those countries it may become a forest- and useful timber-tree. In July 1856, complaints were heard that, in spite of the most careful culture, a peculiar disease had befallen this new *Sequoia*, in consequence of which the twigs were observed to dic off in the same manner as they do in *Cryptomeria Japonica*. Horticulturists began to take alarm, and feared that their new acquisition would inevitably be lost; but Dr. Lindley soon discovered that, though the twigs died, the main stem and branches continued to grow vigorously, and that the so-called disease was constitutional, and could not be looked upon as a sign of ill-health, or a proof of bad culture. In 1858 it bore ripe fruit in England, under the skillful treatment of Mr. J. Buckle, at Thetford.

8. *Prodromus Descriptionis Animalium Evertebratorum, etc.* Invertebrates collected during the North Pacific Expedition under Captains Ringgold and Rodgers, U. S. N., and described by W. Stimpson. Part VII.—Mr. Stimpson, in this paper, published in the Proceedings of the Academy of Natural Sciences of Philadelphia (Dec. 1858), continues his catalogue, notes and description of species of Crustacea from the North Pacific expedition. The number of species brought home by Mr. Stimpson was very large, and the new species alone exceed six hundred. Part VII contains the Anomoura. The collections in this tribe number 83 species; and with the help of extensive collections of the described species, he has been enabled to give the subject a careful revision. In the Dromia tribe he has instituted the new genera *Dromidia* (for *Dromia hirsutissima*, Lamk.), *Cryptodromia* (for *Dromia nodipes*, Lamk.), *Pseudodromia*, *Petalomera*, *Conchoecetes* (for *Cancer artificiosa* Herbst). The large genus *Porcellana* he has subdivided, apparently on good grounds, as follows:

A. *Antennarum externarum articulus primus brevis, marginem carapacis superiorem non attingens.*

Petrolisthes, nov. gen. Carapax depressus, subovatus, non latior quam longior; fronte triangulari, margine plus minusve undulata, dentata vel integra. Oculi sat grandes. Antennarum pedunculus plus minusve cristatus. Chelipedes lati, depressi. Pedum ambulatoriorum dactyli normales, i. e. breves, sat robusti, unguiculo unico.—*Typus*, P. violaceus. *Porcellana violacea*, Guerin; Mag. de Zool., 1838, p. 5, pl. xxv, f. 2. *P. macrocheles*, Pœppig.—Chili.

Pisosoma, nov. gen. Carapax rotundatus, sat convexus, non longior quam latior. Frons superne visa recta, integra. Chelipedes crassi. Dactyli pedum ambulatoriorum normales.—*Typus*, P. pisum. *Porcellana pisum*, M. Edw.; Hist. Nat. des Crust. ii. 254.—Mari Orientali.

B. *Antennarum externarum articulus primus plus minusve productus et margini carapacis junctus; articulus secundus orbitâ remotus.*

Raphidopus, nov. gen. Carapax rotundatus, latior quam longior. Frons non prominens, fere recta, tridentata. Oculi minuti. Pedum ambulatoriorum dactyli longi, recti, gracillimi compressi et acutissimi.—*Typus*, R. ciliatus, infra.

Pachycheles, nov. gen. Carapax rotundato-ovatus, non longior quam latior; epimeris postice solutis, parte posteriore quadrata, interstitio cutaneo disjuncta. Frons medio parum prominens, subacuta. Antennarum articulus primus minus productus. Chelipedes crassissimi, rugosi; carpo brevi. Pedum ambulatoriorum dactyli normales.—*Typus*, P. grossimanus. *Porcellana grossimana*, Guerin; Mag. de Zool. 1838, pl. xxvi, f. 3.—Chili.

Megalobrachium, nov. gen. Carapax rotundatus, non longior quam latior. Frons augusta, laminata, parum prominens, fere recta. Oculi minuti. Chelipedes crassi, mero magno, manu brevi. Pedum amb. dactyli normales.—*Typus*, M. granuliferum, Stm.—Ins. Antillarum.

PORCELLANA, Lam'k, restrictum. Carapax plerumque longior quam latior, lateribus carinatus; epimeris integris. Frons sat lata, prominens, plus minusve dentata. Orbitæ profundæ. Antennarum articulus primus valde productus, intus acutus. Chelipedes sat depressi; carpo brevi, margine anteriore intus sæpius unilobato; digitis sæpius contortis. Pedum amb. dactyli normales, sat longi. *Typus*, P. platycheles, Lam'k; An. s. vert., v. 230.—Europa.

MINYOCERUS, nov. gen. Carapax angustus. Frons tridentata. Antennulæ longiores, articulo primo magno depresso, dentato. Antennarum articulus primus ei *Porcellanæ* similis; pars mobilis minuta, qnadriarticulata, quam art. primus non longior. Chelipedes debiles. Pedum amb. dactyli normales.—*Typus*, M. angustus. *Porcellana angusta*, Dana; loc. cit. i. 423, pl. xxvi, f. 12.—Brasilia.

PORCELLANELLA, White. (Voy. Rattlesnake, ii. 394.) Carapax oblongus, multo longior quam latior, lateribus fere parallelis; lobulus gastricis obsoletis. Frons horizontalis, laminiformis, valde prominens, tridentata. Antennæ ei *Porcellanæ* similes. Chelipedes læves, carpo brevi, manu elongata. Pedes ambulatorii parvi, mero crasso, dactylis brevibus, uncinatis, compressis, multi-unguiculatis.—*Typus*, P. triloba, White; l. c., ii. 394, pl. v, f. 2.

POLYONYX, nov. gen. Carapax rotundato-ovalis, latior quam longior, convexus, lævis. Frons sat angusta, recta. Antennularum articulus primus non dentigerus. Antennarum articulus primus prælongus. Oculi minuti. Chelipedes læves; mero magno. Pedum amb. dactyli brevissimi, lati, intus bi- vel multi-unguiculati. *Megalobrachio* affinis, dactylis exceptis.—*Typus*, P. macrocheles. *Porcellana macrocheles*, Gibbes; Proc. Am. Assoc. 1850, p. 191.—Carolina.

A list of all known species pertaining to each of these proposed genera is added, after much careful study of specimens.

Under the Hippidæ there is the new genus *Mastigopus*, and under Albunidæ, *Lepidopa*. Among the Lithodea, the *Lithodes hystrix* of De Haan is referred to the new genus *Acantholithus*. Among the Paguridea, there are the new genera *Petrochirus* (for the *Pagurus granulatus* Oliv., M. Edw.), *Isocheles* (for the *Bernhardus æquimanus* Dana), and *Spiropagurus* (for the *Pagurus spiriger* De Haan).

9. *Memoires pour servir a l'Histoire Naturelle du Mexique, des Antilles et des États-Unis;* par HENRI DE SAUSSURE. Première livraison, *Crustacés nouveaux du Mexique et des Antilles.* 4to pamph. pp. 80 and 6 plates. Geneva, 1858.—The materials for this work were collected by the author himself during his visit to America. The Mexican Crustacea are all from the eastern or Gulf shores. There are in all fifty-six species described, forty-nine of which are believed by the author to be new. Besides these, as is stated in the preface, several probably new species were collected, about which the author could not be certain, for want of access to books and collections;—a want certainly unfortunate, as it seems to have caused M. de Saussure to fall into some errors regarding what he did venture to publish. At the present day it will be found highly desirable for those writing upon subjects connected with American zoology, to consult the works of American naturalists. In the case before us for instance, a knowledge of the carcinological writings of Say and Gibbes would have enabled the author to have rendered his work more accurate, and saved him some labor.

In the preface Mr. de Saussure gives some interesting general remarks, including details confirmatory of the principle first pointed out by Prof. Dana,—that Crustacea attain their maximum of development in the temperate, and not as with other Articulates, in the tropical zone. He is in error, however, in asserting that the "langouste" (*Palinurus*) inhabits the latitude of Philadelphia and New York.

The diagnoses of most of the species were published in the *Revue Zoologique* for the year 1857. In that journal two new genera were described; *Pseudotelphusa*, which Mr. de Saussure now considers identical with *Potamia* (*Boscia*); and *Halopsyche*, referred to Gebiens, which is now acknowledged to be *Alpheus*. In fact *Halopsyche lutaria* is closely allied if not identical with *Alpheus heterochelis* of Say. In describing new species it is always a great aid to their subsequent recognition, to mention those forms to which they most approximate in character, and if closely allied, to indicate the differences. But the author even when describing species apparently identical with previously described ones well known in this country, neglects to make such comparisons.

We should scarcely have ventured upon the following criticisms were it not for the excellent figures which adorn the work, and enable us to recognise several of the species with considerable certainty. The author has failed to apply some of the recent improvements in the science, neither De Haan's subdivision of *Lupa* nor Dana's of *Pagurus* being adopted, while more doubtful Parisian novelties of classification, as in *Grapsus*, are fully recognised. *Pericera bicornis* De S., seems to be very near to *P. bicorna* (Edw.) Gibbes; if distinct it should certainly receive a more diverse name. *Lambrus crenulatus* is interesting as being the first species found on the American shores, of a genus so abundantly represented on those of the old world. *Chlorodius americanus* seems to be one of the numerous varieties of *C. floridanus* Gibbes. Three new species of *Panopeus* are described, *P. occidentalis*, *serratus*, and *americanus*, from Guadeloupe, all closely allied to *P. Herbstii*, (with which they should have been compared,) but apparently distinct. We have specimens of *P. serratus* from Florida. The genus *Portunus* is new to our waters; the author describes one species, *P. guadulpensis* (guadelupensis?). The three species referred to Milne Edwards' genus *Metopograpsus* will not probably fall into that group; at any rate *M. dubius* De S., is identical with *Pachygrapsus transversus* Gibbes, a common West Indian species, and the other two species seem to be closely allied, and also referable to *Pachygrapsus*. In the *Metopograpsi*, an East Indian and Pacific group, the internal suborbital lobe is joined to the front. *Plagusia gracilis* appears to be a good species, differing from *P. Sayi* in the quadrilobate margin of its epistome. *Hepatus tuberculatus* De S. should be compared with the young of *H. decorus*. *Remipes cubensis* is a good species, characterized by the marginal band of lineolæ uninterrupted by a longitudinal sulcus. We had almost simultaneously indicated this species as *R. barbadensis*, it being the *Squilla barbadensis ovalis* of Petiver. *Pagurus cubensis* De S. is probably *Clibanarius sclopetarius*, as the characters agree except in one point;—it is said of the feet that "La première paire atteint un peu au delà du milieu du troisième article de la deuzième paire." We presume however that the author means the third of those joints which project from beneath the carapax. *Caridina mexicana* would be more properly referred to *Atyoida*, for in *Caridina* the second pair of feet have a long slender carpus not bifurcated at the extremity. (See M. Edwards; Hist. Nat. des Crust., pl. 25bis, f. 4.) Seven new *Palemons* are described, which we should have judged to be fresh-water species, but our author says that they, as well as *P. jamaicensis*

are found on the coasts. Of Tetradecapoda twelve species are described, —one *Amphitoe*, seven *Porcellios*, one *Armadillo*, one *Pseudarmadillo*, (a new genus between *Armadillo* and *Armadillidium*,) one *Anilocra*, and one *Cymothoa*. The only Entomostracan is *Chlamydotheca azteca*, of a new generic type forming a subdivision of the old genus *Cypris*.

W. S.

10. *Observations on the Genus Unio;* by ISAAC LEA, LL.D.—In our notice of Dr. Lea's Memoir we stated that the embryonic form of the shell in the case of 38 species of Unionidæ is figured without details on one of the plates. We intended to say without details on the plates. There are detailed descriptions occupying eight pages of the memoir.

11. *Catalogue of the Described Coleoptera of the United States;* by FRIEDRICH ERNST MELSHEIMER, M.D., revised by S. S. HALDEMAN and J. LECONTE. 174 pp. 8vo.

12. *Catalogue of the described Diptera of North America;* prepared for the Smithsonian Institution by R. OSTEN SACKEN. 92 pp. 8vo.

These two works were issued the past year by the Smithsonian Institution. They are of great value to all interested in these departments of Entomology.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Appendix to the Article on Fluctuations of the Water Level of the Lakes* (p. 305); by C. WHITTLESEY. (Received too late for insertion in connection with the article.)—Since this article was written I have seen the following notices of the discovery of a lunar tide on Lake Michigan, by gentlemen who have made observations at Milwaukee and at Chicago.

"It may not be improper for me to add, that very numerous observations have been made here to ascertain the character of the fluctuations of the level of Lake Michigan, one of the results of which was announced by me in the Milwaukee Daily Sentinel & Gazette, of Sept. 3d, 1849, in the following words:

'*An Important question settled.*—By a series of observations made every three hours during the month of August, 1849, I have ascertained that there *is a slight lunar tide on Lake Michigan.*'

Other subsequent observations made *hourly both day and night*, for two months, fully confirmed this conclusion. I. A. LAPHAM.

Milwaukee, Dec. 24th, 1858."

At a meeting of the Chicago Historical Society, Nov. 30th, 1858, I find among the proceedings the following report:

"An interesting announcement was made at this meeting by Lieut. Col. J. D. Graham, U. S. A., of the recent discovery of the operation of lunar attraction upon the waters of Lake Michigan.

A series of accurate tidal observations has, during the last four years, been prosecuted under the superintendence of Col. Graham, resulting in the discovery above noticed. The supposed influence is more noticeable at the period of the moon's conjunction or opposition, and in tranquil weather, the observed extent of it being about two-tenths of a foot.

The brief announcement by Col. Graham will, it is hoped, be followed by a detailed statement of facts and data at a future day."

2. *Report on the History and Progress of the American Coast Survey up to the year* 1858, by the Committee of twenty appointed by the American Association for the Advancement of Science at the Montreal meeting, August, 1857. 88 pp., 8vo.—The committee of twenty appointed by the Association, consisted of Judge J. K. Kane, Pres. Amer. Phil. Soc. Pa., Gen. J. G. Totten, Chief Engineer U. S. A., Prof. Benjamin Peirce, Harvard College, Mass., Prof. John Torrey, U. S. Assay Office, N. Y., Prof. Joseph Henry, Sec. Smithsonian Institution, D. C., Prof. J. F. Frazer, University of Pennsylvania, Pa., Prof. Wm. Chauvenet, U. S. Naval Academy, Md., Pres. F. A. P. Barnard, University of Mississippi, Miss., Prof. John Leconte, College of South Carolina, S. C., Prof. Wm. M. Gillespie, Union College, N. Y., Prof. F. H. Smith, University of Virginia, Va., Prof. W. H. C. Bartlett, U. S. Military Academy, N. Y., Prof. Wolcott Gibbs, Free Academy, N. Y., Prof. Stephen Alexander, College of New Jersey, N. J., Prof. Lewis R. Gibbes, Charleston College, S. C., Prof. Joseph Winlock, Sup. Am. Alm., Ky., Prof. James Phillips, University of North Carolina, N. C., Prof. Wm. Ferrel, Nashville, Tenn., Prof. Edward Hitchcock, Amherst College, Mass., Prof. James D. Dana, Yale College, Conn. After the death of Judge Kane in February, 1858, Pres. F. A. P. Barnard was appointed chairman of the committee.

The Report treats of the methods of coast survey in different countries, the history of the Coast Survey in this country, the results up to 1858, and the benefits to navigation, commerce, and general science. We have presented in a recent article a review of some of these results. This Report gives a broader and fuller exposition of the whole subject, and exhibits in a strong light the indebtedness of the country to the ability and excellent management of Prof. Bache, the Superintendent. It is only necessary to cite here from the concluding pages of the Report the recapitulation of the conclusions concurred in by "the Committee with entire unanimity."

"1. The American Coast Survey, in its inception, was a work imperatively demanded by a due regard to the industrial interests of the country, dependent, as they are, greatly upon the prosperity of commerce for their free development.

2. The indecision which marked the early policy of the government in regard to this Survey, and the consequent delay of its efficient operations, and postponement of its beneficial results, were of manifest disadvantage to the material welfare of our people, and cannot but be still subjects of serious regret.

3. The economical value of such surveys is attested by the universal voice of all commercial men, and by the concurrent practice of all commercial nations, no less than by the melancholy records of marine disaster annually occurring upon every unexplored coast.

4. Their scientific value is witnessed, in the instance of the American survey, by the spontaneous tributes of approval frequently and freely bestowed upon it—no less in regard to the ability, energy and skill displayed in its management, than to the magnitude, variety, and oftentimes curious interest of the results it has wrought out—by individuals and organized bodies of men, whose high position as scientific authorities renders their opinions upon subjects of this nature entirely conclusive.

5. This work has conferred many valuable benefits upon science, indirectly and incidentally, in the invention or perfection of instruments, in the improvement of methods of observation or of computation, in the development it has given to special subjects of interesting inquiry, and in the stimulus which it has furnished to the scientific talent of the country, especially in the field of astronomical observation and investigation.

6. A careful study of the progress made from year to year, especially since the enlargement of the scale of operations under the present superintendent, affords ample evidence that the work has been expeditiously prosecuted, and the amount accomplished up to the present date is materially greater than has ever been accomplished in any other country in the same length of time, and with the same means.

7. Compared with the same surveys executed or in progress of execution by foreign governments, the American survey has been conducted with remarkable economy.

8. Compared with such foreign surveys, the quality of the work done in this will bear the test of any standard that has ever been anywhere set up, and is such as to reflect honor on the scientific character of our country in the eyes of the world.

9. Every consideration of economy, of humanity, and of regard for the reputation of the country, demands that the work should be prosecuted with undiminished activity, until every portion of our coast shall have been as thoroughly explored and mapped as those have been already in which its operations commenced.

10. Conclusive reasons, involving other weighty public interests no less than this, but connected also with the project of verifying in the happiest manner the geodesy of our extended and circuitous coast, conspire to render the triangulation of the great Appalachian chain of mountains a most desirable undertaking, and encourage the hope that our government will very early direct that most important work to be executed.

11. The publication in full of all the observations upon which the published results of the Coast Survey are founded, together with the methods employed in the reduction and discussion of the observations, would be a contribution to science, and especially to the science of geodesy, of inappreciable value, besides being necessary to secure the records against loss; and the committee earnestly hope that the government may not fail to provide the means for the adequate and rapid prosecution of the work.

12. The existing organization of the Survey, judged in the light of the experience acquired by our own and by foreign governments in the management of such works, is, in the deliberate opinion of the committee, preferable to any other that has ever been suggested."

3. *Note on the Height of the Atmosphere.*—A letter from Mons. Emm. Liais published in the *Comptes Rendus* (Jan. 10, 1859, p. 109) gives the results of his inquiries into the height of the atmosphere as deduced from observations on polarization made at the tropics at the commencement of dawn and the end of twilight. The letter is dated San Domingos, Bay of Rio Janeiro, Dec. 6, 1858. His observations at that place, Dec. 1, 2, and 3, indicated that the limit of atmospheric polarization was $9^m\ 40^s$ in passing from 20 degrees east of the zenith to 20 degrees west. But at San Domingo, of which the latitude is 23° S., the limit of the

shadow passes over 25·6 kilometres per minute, or 247·5 kilometres in $9^m\ 40^s$. From this the height of the atmosphere is calculated to be 340 kilometres or 211 miles.

4. *Museum of Comparative Zoology at Cambridge.*—Since our last (see pp. 295–299 this vol.) a new and most encouraging aspect has come over this important movement. The legislature of Massachusetts, after listening to the persuasive eloquence of Agassiz, exhibiting in the most catholic and unselfish spirit the claim of the subject upon the public purse, has appropriated one hundred thousand dollars for a zoological museum, on the condition that as much more should be subscribed, including the legacy of Mr. Francis C. Gray of $50,000, for the same purpose. The subscription soon amounted to $80,000 besides this legacy, or in all, including the bounty of the State, to the magnificent sum of $230,000 (*two hundred and thirty thousand dollars*). It is now proposed to make up the whole amount to a quarter of a million.

It will be remembered that the legacy of Mr. Gray is for the expenses of the museum exclusive of salaries or buildings.

This bounty of the State is derived from the sales of a large tract of land in the city of Boston reclaimed by the commonwealth from the "*Back Bay*," and hence called the "*Back Bay lands*." The whole proceeds of this noble domain so far as by partition with the city and the contractors they belong to the State (and they are estimated by millions) are solemnly dedicated to the cause of education—ever held most sacred in great-hearted Massachusetts. Were it pertinent to our pages we should delight to transfer to them all that relates to this subject, but we will content ourselves by giving the act of incorporation for the "*Museum of Comparative Zoology*, passed April 6, 1859."

"An act to incorparate the Trustees of the Museum of Comparative Zoology:

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows:

Section 1. The Governor, the Lieutenant Governor, the President of the Senate, the Speaker of the House of Representatives, the Secretary of the Board of Education, the Chief Justice of the highest Judicial Court, *ex officiis*, and Louis Agassiz and William Gray, together with Jacob Bigelow, James Walker, George Ticknor, Nathaniel Thayer, Samuel Hooper, Samuel G. Ward and James Lawrence, and their successors, are hereby made a body politic and corporate, by the name of the 'Trustees of the Museum of Comparative Zoology,' with all the powers and privileges set forth in the Forty-fourth Chapter of the Revised Statutes, so far as the same are applicable to the purpose for which said Corporation is established, as hereinafter mentioned, and not inconsistent with the provisions of this Act.

Section 2. Said Corporation may receive, hold, purchase and possess real and personal property not exceeding three hundred thousand dollars in value, to be used and improved for the erection, support and maintenance of a Museum of Comparative Zoology at Cambridge, in this Commonwealth; and the sum of fifty thousand dollars, heretofore contributed in aid of the Museum of Comparative Zoology by William Gray, shall be deemed to be a part of the sum required to be raised by private subscription for the said Museum, as a condition precedent to the payment by the Commonwealth to said Trustees of any part of the avails of the sales of land in the Back Bay.

Section 3. The places of Louis Agassiz and William Gray, whenever the same or either of them shall become vacant by death, resignation or otherwise, shall be filled by a concurrent vote of the Senate and House of Representatives, and the

same course shall be afterwards adopted when the place of the successor of either of them shall become vacant; but any vacancy occasioned by the death, resignation or otherwise, of any of the other persons named in this Act (except the members designated *ex-officiis*), or of the successors of such persons, shall be filled by election by the whole board of Trustees, at meetings specially called for that purpose.

SECTION 4. The said Trustees shall arrange, so far as may be done consistently with the interests of the institution, for the distribution of duplicate specimens, by exchange or otherwise, among other colleges and institutions of learning in this Commonwealth and elsewhere. And the Museum belonging to said Trustees shall, at all reasonable times, and under reasonable regulations, be kept open to the public free of charge.

SECTION 5. This act shall take effect from and after its passage."

5. *Conservatory of Art and Science.*—By force of that "perpetual semination" which Lord Bacon says is ever the surest sign of a great principle, Agassiz's example has awakened, it seems, in the whole body politic in Massachusetts a noble zeal to secure for the citizens of the whole State a truly National Museum, on the broad plan of the British Museum, or rather, it is said, to unite the features of the Paris Garden of Plants with the *Conservatoire des Arts et Metiers*, to be located at Boston and endowed and sustained by the public purse. This movement promises to be successful as soon as a proper plan is matured. The Committee on Education commended it to the legislature in the strongest manner, and only certain considerations of a private nature between the City of Boston and the Commonwealth prevented its taking the form of law a month ago. The source of endowment is to be also the Back Bay lands. The spirit of Boston and its commonwealth is adequate not merely to conceiving, but to giving practical efficiency to any plan for a great public museum which the wisdom of its citizens may elaborate; for there, is ever found the happy union of the designing mind and the executive hand—the ability both to *say* and to *pay*.

6. *Legacy to Yale College, New Haven.*—The bequest of the Hon. Henry L. Ellsworth to Yale College, amounting, it is estimated, to two or three hundred thousand dollars, is appropriated by the will to scholarships, and is therefore rather a gift to the public than to the College itself. The will is to be contested and the issue is doubtful. If sustained, the College will receive from it only tuition fees, and these, as is well known, meet but little more than half the expenses of instruction. It is a munificent donation to the general interests of public education.

7. *Journal of the American Geographical and Statistical Society.*—The American Geographical and Statistical Society of New York has commenced the publication of a monthly Journal of thirty-two large octavo pages. The enterprise is important and deserving of hearty encouragement. We wish it complete success.

The object of the Journal, as stated in the introduction, is to furnish information on Geographical and Statistical subjects, by the publication, in a form adapted to their preservation and convenient use, of the papers read before it, and of communications with which it may be favored; to cultivate and cherish a taste for research in the wide field of Geography and Statistics; and to create among its members an interest that will secure their hearty co-operation in the promotion of its objects. In the absence, both in the Federal and State Governments, of bureaus specially devoted to these subjects, a work similar in character to the one now presented seems indispensable to their proper elucidation and publication.

OBITUARY.—Prof. WILLIAM W. MATHER, acting President of the University of Ohio at Columbus, died in that city, February 26, 1859. He was graduated at the U. S. Military Academy in 1828—where he continued to reside as instructor in mineralogy and geology, and assistant to the professor of chemistry until 1834–5. In 1836 he resigned his commission in the army and devoted himself exclusively to scientific pursuits. Being appointed by the Governor of New York one of the four principal geologists for the survey of that state, his final report on the geology of the first district was published in a large quarto in 1843. This was his most important original work—and it will always bear honorable testimony to his ability and accuracy as an observer in this department of nature. He held the post of geologist to the state of Ohio from 1837 to 1840, and published three annual reports of which notice will be found in the first series of this Journal. He was also for a time charged with a geological reconnoissance of the state of Kentucky and published one preliminary report on that state. Since 1842 he has been connected as an instructor with the University of Ohio. His contributions to the pages of this Journal have been numerous and important both in chemistry, mineralogy and geology. His paper, entitled "Contributions to Chemical Science," printed in vol. XXVII, first series (1835), gives ample evidence of his ability in practical chemistry. His age is not reported; but he could not have been far from fifty-five years. He was a native of Middlesex county, Connecticut.

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W. BUCKLAND: Geology and Mineralogy considered with reference to Natural Theology. New edit., with Additions by Owen, Phillips, Rb. Brown, and Memoir of the Author. Edited by Fr. T. Buckland. 2 vols. *London*, 1858. 8°. 760 pp.

JOURN. ACAD. NAT. SCI. PHILAD., Vol. VI, Part I.—96 pages 4to, with 20 p'ates.

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